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(COMMONWEALTH OF AUSTRALIA.)
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(ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.)

135.
REPORT OF EXECUTIVE COMMITTEE.
1916 (June)



EXECUTIVE COMMITTEE:

Chairman : Senator A. GARDINER, Vice-President of Executive Council.

Deputy Chairman : Professor D. ORME MASSON, D.Sc., F.R.S.

Professor T. R. LYLE, M.A., F.R.S.

G. D. DELPRAT, Esq.

„ R. D. WATT, M.A., B.Sc.

E. A. MANN, Esq., F.I.C.

A. B. PIDDINGTON, Esq., K.C.

314 Albert-street, East Melbourne,
21st June, 1916.

In accordance with the resolution arrived at by the Advisory Council on 15th April, 1916, the Executive Committee desires to submit the following Report of the work done since that date and of its preparation for future operations.

STATE COMMITTEES.

The recommendations of the Advisory Council as to the appointment of additional members to provide a nucleus of a Committee in each State of the Commonwealth were duly submitted to the Commonwealth Government and considered by them. The result is embodied in a memorandum from the Acting Secretary to the Prime Minister's Department, which is attached hereto. This memorandum was made the basis of communication by the Commonwealth Government to each of the State Governments, but up to the present the nominations necessary for the appointment of the extra members have only been received from Queensland, so that so far State Committees have only been constituted in New South Wales, Victoria, and Queensland. Those of South Australia, Western Australia, and Tasmania have still to be formed, though it is expected that the necessary nominations may now be shortly received. This delay in the constitution of the State Committees is accountable for the Advisory Council not having been called together, as the Executive considered it would be desirable to wait until all Committees were formed before having a general meeting. As there seemed, however, no reasons for delaying the activities of those Committees which were in existence in the three States first named, they have been called together, and are now at work. The provisions of the Government Memorandum regarding the appointment of Associate Members have also been taken advantage of in these three States.

As the Executive, moreover, was anxious that the Advisory Council should be fully advised on all matters, it has decided to submit this Report without waiting for a meeting of the Council.

ORGANIZATION OF OFFICE.

The first week or two of its existence was largely occupied by the Committee in arranging for the necessary machinery to enable it to carry out its work.

The necessary office accommodation has been very kindly placed at its disposal by the Inter-State Commission of Australia, at 314 Albert-street, East Melbourne. The Committee desires to express its appreciation of the valuable assistance thus rendered by the Inter-State Commission., A Secretary (Mr. R. W. Constable) has been appointed, and a typiste engaged, and all essential office requisites are now installed.

A carefully thought out system of card indexing and filing has been instituted by the Secretary, so as to introduce a methodical yet elastic scheme of record from the commencement. Supplies of all the leading newspapers in the Commonwealth are received regularly, and provide a method of keeping in close touch with local developments in all States.

All meetings of the Committee are held at the above offices, and Tuesday and Thursday evenings in each week are so occupied. Altogether fifteen meetings of the Executive have been held up to date.

BUREAU OF INFORMATION.

The Committee considered that one of the matters demanding its earliest attention was the establishment of that Bureau "for the collection of industrial scientific information and its dissemination," which was suggested to the Council in the original report on the constitution and functions of the proposed Institute.

With this object in view, it held interviews with G. H. Knibbs, Esq., C.M.G., Commonwealth Government Statistician, and E. J. La T. Armstrong, Esq., Director of the Public Library, Melbourne, to obtain information as to the nature of such Bureaux in other parts of the world.

In view of the expense and inadvisability of establishing a separate library, it was determined that such a bureau could best be established at the Public Library in Melbourne, where it is hoped a room will be placed at the disposal of the Committee. It was resolved therefore to appoint a special officer as Science Abstractor, who should work there under the directions of the Committee in searching the literature there available, or which may be obtained for the purposes of the Council, and collating all information on particular subjects as may be required from time to time.

From this commencement such gradual extension of staff will be made from time to time as is necessary for work on a larger scale and the dissemination of the information obtained amongst those actually engaged in various industries.

In pursuance of this plan, advertisements have been published throughout Australia calling for applications for the post of Science Abstractor at a salary of £300 per annum. Numerous applications have been received, which will be considered after the 23rd June, when applications are to close.

COLLECTION OF DATA.

Other duties committed to the Council included :—

- (a) To consider and initiate scientific researches in connexion with or for the promotion of primary or secondary industries in the Commonwealth.
- (b) To invite certain classes of institutions or bodies "to suggest branches of industrial scientific research in which investigations would be of immediate practical use."
- (c) "To seek the co-operation of existing institutions and utilize the resources of staff and equipment at our disposal at the present time."

In order to obtain the information required under these headings the Committee have prepared and issued certain circular letters as follow :—

1. *To all Universities, Higher Technical Schools, and Government Technical Departments.*—Inquiries for the purpose of taking a census of scientific personnel and equipment available for research.
2. *To all State Committees.*—Queries to form the basis of a census of industries and their problems, and suggestions that aid be obtained from Statistical Departments.
3. *To all Universities and Higher Technical Schools.*—Regarding provisions for training future investigators and their future wants for such purposes.
4. *To the Public Service Commissioners of Australia.*—Regarding the possibilities of training and prospects for encouragement of technical officers in Government Departments.

These circulars are still receiving the attention of those to whom they were addressed, and it is expected that the replies when received will provide the Council with a full knowledge of the resources of the Commonwealth, present and prospective, with regard to these matters of industrial research. Copies of the circulars are attached as appendices to this Report.

IMPERIAL ADVISORY COUNCIL.

An important communication has been received through the Prime Minister in the form of a despatch from the Secretary of State for the Colonies enclosing a memorandum from the Committee of the Privy Council regarding the co-operation of the Dominions in the work of the British Advisory Council on Science.

A draft of a reply has been prepared and submitted to the Prime Minister for his approval. Copies of these documents are attached.

SPECIAL PROBLEMS.

In the initial report on the constitution of the Institute a number of problems were suggested for the consideration of the Advisory Council as being specially pressing.

All these have been made the subject of inquiries by the Executive, and the results are indicated in the following enumeration:—

1. *The Sheep-fly Pest.*—The conjoint work on this question being carried out by the Departmental Committee of the Government and the Pastoralists Committee in New South Wales appears to the Executive to have been so admirably conceived and vigorously carried out as to obviate the necessity for fresh investigations by the Council; but the Committee has offered its assistance to the bodies mentioned if it can in any way further their researches. Reports have also been received from the Queensland Government, and are under consideration.
2. *Improved methods of extracting Zinc from Australian Ores, including the Commercial Manufacture of Electrolytic Zinc.*—Inquiries are still proceeding.
3. *Utilization of Brown Coal, with Recovery of By-products.*—Inquiries proceeding.
4. *Introduction of a Mechanical Cotton Picker.*—The Committee has acquainted itself with the factors in this problem, has interviewed one inventor, and is in communication with another, and hopes to shortly pursue the matter further. Cordial co-operation has been obtained from the Queensland Government.
5. *Eradication of the Prickly Pear.*—The Committee is at present making itself acquainted with the experiments already being carried on in Queensland before forming any opinion on this matter.
6. *Production of Aluminium and Ferro Alloys.*—Some very interesting evidence has been laid before the Committee on the subject of production of aluminium, especially in connexion with the simultaneous production of potash salts from alunite, but the inquiries are not yet complete.

With regard to Ferro Alloys, it is found that considerable work on this subject has been carried out by Mr. A. J. Higgin and Mr. E. B. Brown (Lecturers on Metallurgy and Electrical Engineering respectively at the Melbourne University), at the instance of the Federal Munitions Committee. Further assistance being required for the completion of this work, the matter was handed over to the Executive by the Federal Munitions Committee. After an interview with Mr. Higgin and a report by Professor Lyle, the Executive has made a grant of £150 for this work, in addition to £100 previously granted by the Commonwealth Government.

It is estimated that this will be sufficient to complete the researches on hand on the production of chrome and tungsten alloys with iron, which are important in connexion with the production of high-speed tool steel. It is possible that the Committee may appoint an additional investigator to assist Mr. Higgin in his work.

Steps have also been taken which may lead in the near future to the commercial production of this steel; but the matter has not yet reached a stage at which the Committee can report.

7. *Recovery of Potash, Manufacture of Alkali, and Recovery of Sulphurous Acid Gas.*—Inquiries have been begun, but are not yet complete.

8. *Cultivation of useful Indigenous Grasses and Salt Bushes.*—Several interesting communications received on this subject have impressed the Committee with its importance, especially in connexion with the extension of agriculture into the drier areas of Australia. The Committee has not yet, however, received sufficient information on all the questions involved to enable it to determine any definite course of action.
9. *Manufacture of fine Chemicals, Drugs, and Explosives.*—A special Sub-Committee appointed by the Executive has been considering this matter, and is prosecuting inquiries, especially as to the manufacture of the following substances:—Carbide, cyanamide, caustic soda, chlorine, copper sulphate, superphosphate, potash salts. The large field to be covered, however, has rendered it impossible up to the present for this Sub-Committee to present a report.

OTHER INQUIRIES MADE BY THE COMMITTEE.

In addition to the matters already dealt with, there have been various subjects which have been brought before the Committee, and which they have considered, with a view to mapping out a sphere of practical usefulness for the Institute. Reference may now be made to the most important of these.

Utilization of Waste Timber.—The enormous waste which takes place in connexion with the timber industry of Australia has been brought before the Committee in a convincing manner by Mr. C. E. Lane Poole, Conservator of Forests in Western Australia, and an instructive interview was held with Mr. R. H. MacMillan, Chief Forester of British Columbia, who is visiting Australia. There is doubtless a large field for inquiry here, and its importance was emphasized by the recent Forestry Conference in Adelaide, which resolved that research into forestry problems was necessary, but referred the matter to this Council. So far the inquiries have been directed towards two possible methods of utilizing this waste, viz. :—

- (a) By making wood pulp for paper manufacture.
- (b) By subjecting it to destructive distillation for the manufacture of acetic acid, acetone, methyl alcohol, creosote oils, &c.

The matter has not yet reached a sufficiently advanced stage to permit of the expression of definite views or the determination of what action is desirable.

Soil Survey.—Strong representations were received from the Farmers and Settlers Association and the Institution of Licensed Surveyors in New South Wales of the desirability of organizing some system of soil survey in connexion with the promotion of agriculture in Australia.

The Executive appointed a special Sub-Committee to consider this subject, and it has presented a report recommending as a commencement the collation of such relevant information as is already available in the various State Government Departments, and its publication in a form which will give a complete presentation of the conditions throughout Australia so far as already determined. This would then serve as a starting point for any forward movement towards an extension of the survey to any districts not yet thoroughly mapped. It is proposed that uniformity should be secured by intrusting the collection of these data to a Central Committee, possibly with one specially appointed expert executive officer. The proposals have been submitted to the Ministers of Agriculture in all the States for an expression of their views.

Breeding of Drought-resisting Wheat.—This question is cognate to and has been receiving consideration in conjunction with that of breeding fodder grasses, salt bush, &c., already referred to, but the inquiries have only reached a preliminary stage.

In all cases the Executive has adopted the procedure of first consulting, either by letter or interview, any person who it believed was specially qualified to speak on any subject being discussed, so as to ascertain the exact stage at which any inquiry on the question had already arrived—in other words, to learn the present position of the problems and the special points requiring elucidation. This has been followed by similar inquiries as to the best means by which the aid of the Council could be rendered. In two instances already described, special Sub-Committees have been formed to deal with the subjects in further detail, and in each case expert assistance has been sought outside the Executive Committee in addition to that available amongst its own members.

FUTURE OPERATIONS.

In suggesting definite lines of work to be followed by the Council in its future activities, some difficulty is experienced owing to the provisional nature of the functions committed to it. As its duties will cease with the permanent establishment of the Commonwealth Institute of Science and Industry, the Committee considers that its principal functions have been to collect information, and pave the way for the establishment of the permanent body. It is, therefore, of opinion that no far-reaching proposals for future work can at present be made, but recommends that the work of the Council should continue along the lines already followed, so that as soon as the Institute has been actually formed, it will be in possession of the necessary information to enable a definite policy to be constructed.

The Committee, however, believes that it would greatly accelerate this object if it were to visit the various States and obtain some knowledge of their problems at first hand, and it is probable that this course will be taken at an early date.

The Executive Committee desires to record its special obligation to Mr. E. A. Mann, who has devoted a large amount of his time to the work of the Committee, and for the facilitation of that work has appointed him Honorary Secretary.

ALBERT GARDINER,
Chairman.



COMMONWEALTH OF AUSTRALIA.

PRIME MINISTER'S DEPARTMENT,

Melbourne, 29th April, 1916.

The Acting Secretary,

Commonwealth Science Advisory Council.

I am directed to state, for the information of the Advisory Council, that the Government has considered the resolutions, specified hereunder, of the Council agreed to at the meeting held on the 14th and 15th instant. The decisions of the Government are as indicated :—

1. *Resolution*—That the Chairman of each State Committee shall be *ex-officio* a member of the Executive Committee.

Decision of Government—Approved.

2. *Resolution*—That the local State Committee shall select as its chairman one of its members on the Advisory Council as enlarged.

Decision of Government—Approved.

3. *Resolution*—That the Government be asked to appoint additional members of this Council so as to permit of sub-committees of the Council being formed in each State.

Resolution—That the Federal Government be asked to make such additional appointments to this Council as will insure that no State shall have less than three representatives on the Council in addition to the *ex-officio* members.

Decision of Government—The State Governments be asked to nominate representatives as follows :—

Queensland	...	...	2.
South Australia	...	3—	one of whom shall be a Professor of the University.
Western Australia	...	2—	one of whom shall be a Professor of the University.
Tasmania	...	...	2—one of whom shall be a Professor of the University.

Action is being taken accordingly.

4. *Resolution*—That the Committee in each State consist of the State Representatives on the Advisory Council, together with any other associate members appointed on the nomination of State Governments. These associate members of the State Committees shall not be members of the Advisory Council. The members of the State Committee shall be called together by its chairman.

Decision of Government—The general principles of this resolution were agreed to, but it was decided that the following procedure be adopted in respect of it. The Executive of the Advisory Council is asked to indicate to the Commonwealth Government the branch of science or industry which the committee or sub-committee is to deal with ; that the Commonwealth Government will then communicate with the State Governments as to any persons they may desire to nominate, and that the Commonwealth Government will appoint such associate members.

J. H. STARLING,

Acting Secretary.

COMMONWEALTH OF AUSTRALIA.

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

EXECUTIVE COMMITTEE.

314 ALBERT STREET.

East Melbourne,.....1916.

SIR,

The Provisional Advisory Council of this Institute is at present engaged in collecting information which will aid it in its task of initiating scientific investigations of problems connected with Australian industries. For the purpose of such investigations, it is the Council's intention to seek the co-operation of all existing Australian institutions which are equipped for scientific research, and to utilise as far as may be the services of skilled investigators attached to such institutions. The Council will undertake the cost of any investigation initiated or approved by it, and is prepared to make reasonable financial arrangements in such cases.

As a preliminary step, the Council is compiling a catalogue of laboratories and personnel now available for such work ; and I have the honour to ask you to be good enough to furnish me with information as to the resources of your institution. I shall, therefore, be obliged if you will fill in the enclosed form and return it to me, together with any further notes that you may think desirable.

I may add that the same request is being made, in the first instance, to all scientific departments of the Federal and State Governments, and to all the Universities and higher Technical Schools of Australia.

I have the honour to be,

Sir,

Yours faithfully,



ADVISORY COUNCIL OF SCIENCE AND INDUSTRY
EXECUTIVE COMMITTEE.

314 ALBERT STREET,

East Melbourne,.....

1916.

SIR,

The Provisional Advisory Council of this Institute desires to obtain data for the formation of an estimate of the future prospects of a regular supply of trained scientific investigators available for research work in connection with Australian industries. I have written to you already on the separate question of the laboratories and persons that may be regarded as now available for such investigations as may be initiated by the Institute in the immediate future. The present inquiry, which I am addressing only to the Universities and higher Technical Schools, is concerned more particularly with educational work, facilities, wants, and prospects.

In the opinion of the Council, one of the most important functions of the institute will be to encourage the higher scientific training, and thus increase the output of skilled specialists available in connection with our primary and secondary industries. It is hoped to achieve this result by both direct and indirect means; directly, by the payment of young men and women appointed to assist in specified researches, and also by financial grants to institutions for improved equipment; indirectly, by proving to the public the value of industrial scientific research, and thus increasing the demand for trained specialists and improving the status and emoluments open to them.

I shall be greatly obliged if you will furnish me with a report dealing in particular with the following questions:—

1. Degrees or diplomas granted by your institution in Pure or Applied Science.
2. The approximate number of such graduates or diplomates annually.
3. The approximate annual number of post-graduate research students in Pure or Applied Science.
4. The inducements offered to such post-graduate research students by Research Scholarships or otherwise.
5. The more pressing requirements of your institution for the further encouragement of the higher scientific training, *e.g.*:—
 - (a) Increase of teaching staff.
 - (b) Additional laboratories.
 - (c) Apparatus and equipment.
 - (d) Undergraduate bursaries.
 - (e) Post-graduate resident or travelling scholarships.
 - (f) Fuller acceptance of your degrees or diplomas by outside examining or appointing bodies, such as Government departments or outside corporate institutions.

I trust that you will realise that this information is asked for in no mere inquisitorial spirit, but in the hope that this Institute may, through its relations with the Federal and State Governments and with the means at its own disposal, prove really useful in the near future.

I have the honour to be,

Sir,

Yours faithfully,

AT THE COURT AT BUCKINGHAM PALACE,

THE 28th DAY OF JULY, 1915.

Present :

THE KING'S MOST EXCELLENT MAJESTY IN COUNCIL.

It is this day ordered by His Majesty in Council that the Lord President of the Council, the Chancellor of the Exchequer, the Secretary for Scotland, the President of the Board of Trade, the President of the Board of Education, and the Chief Secretary for Ireland, respectively, for the time being, the Right Honourable Viscount Haldane of Cloan, K.T., O.M., F.R.S., the Right Honourable Arthur Herbert Dyke Acland, and the Right Honourable Joseph Albert Pease, M.P., be, and they are, hereby appointed a Committee to direct, subject to such conditions as the Treasury may from time to time prescribe, the application of any sums of money provided by Parliament for the organization and development of scientific and industrial research :

It is further ordered that during His Majesty's pleasure the President of the Board of Education shall preside over the said Committee in the absence of the Lord President :

Moreover, it is further ordered that, for the purposes aforesaid, there shall be an Advisory Council (consisting of such number of persons holding office for such term as the Committee shall from time to time determine) to which shall stand referred, for their report and recommendation, proposals—

- (i) for instituting specific researches ;
- (ii) for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades ; and
- (iii) for the establishment and award of Research Studentships and Fellowships.

The said Council may itself initiate such proposals and may advise the Committee on such matters, whether general or particular, relating to the advancement of trade and industry by means of scientific research as the Committee from time to time determine.

And it is ordered that the following shall be among the first Members of the Advisory Council :—

Sir William Symington McCormick, LL.D. (Administrative Chairman) ;
The Right Honourable Lord Rayleigh, O.M., D.C.L., LL.D., F.R.S. ;
George Thomas Beilby, Esquire, LL.D., F.R.S. ;
William Duddell, Esquire, F.R.S. ;
Professor Bertram Hopkinson, F.R.S. ;
Professor John Alexander McClelland, F.R.S. ;
Professor Raphael Meldola, F.R.S. ; and
Richard Threlfall, Esquire, F.R.S.

And it is ordered that the Committee may, out of funds provided by Parliament or otherwise available for the purpose, pay such remuneration to the Members of the Advisory Council and such salary to the Administrative Chairman thereof as the Treasury authorize, and defray to such an amount as may be sanctioned by the Treasury any other expenses incurred by the Council in or in connexion with the performance of its duties, and may enter into any contracts incidental thereto.

And it is ordered that the Committee shall in every year cause to be laid before both Houses of Parliament a Report of their proceedings and of the proceedings of the Advisory Council during the preceding year.

ALMERIC FITZROY.

DRAFT REPLY SUBMITTED BY EXECUTIVE COMMITTEE.

Since this correspondence was begun by the Governments of Victoria and of New South Wales, the Commonwealth Government has resolved upon the establishment of an Institute of Science and Industry, the operation of which will embrace all the States. Pending the establishment by Act of Parliament of this Institute, active work has already been begun by an Advisory Council appointed by the Government. This Advisory Council has appointed an Executive Committee, and it is suggested that this Committee should be placed in direct communication with the Committee of the Privy Council.

An account is appended of the proposed constitution of the Institute :—

The Executive Committee of the Commonwealth Advisory Council of Science and Industry has given careful consideration to the memorandum of the Committee of the Privy Council for Scientific and Industrial Research, which deals with the “ suggestions made by the Governments of Victoria and New South Wales for making the scheme for the organization and development of scientific and industrial research applicable to the whole Empire.”

The Executive Committee welcomes the evidence afforded by the memorandum that the suggestions of the Australian State Governments have been received with cordial approval by the Committee of the Privy Council, and that there is therefore a definite prospect of a concerted effort throughout the Empire by means of bodies established in the Dominions and affiliated with the present organization in the United Kingdom.

With regard to the suggestions made in paragraphs 3 to 6 of the Memorandum, the Committee desire to express general concurrence with them and with the opinion that the formulation of precise conditions of affiliation and adoption of definite methods of co-operation are best postponed till experience has been gained. From the outset, however, great advantage will accrue to the Commonwealth Advisory Council if the Committee of the Privy Council will keep it informed of its decisions and actions, as far as it may think fit, and the Advisory Council will in turn furnish reports from time to time as to its own doings.

It may be stated that a beginning has already been made here in the undertaking of functions such as those referred to in paragraphs 8 and 9 of the Memorandum, and in particular, that the Committee is now compiling Registers of Australian Industries, Industrial Problems for Research, and Scientific Personnel and Laboratories available for Research, and that it is also considering the educational facilities and the needs of Australia from the stand-point of the future supply of competent investigators.

In paragraph 7 of the Memorandum it is stated that the necessary first step towards a system of co-operation must be the establishment by the appropriate Government of “ some body or agency having functions analogous to those of the Advisory Council which acts for the United Kingdom.” This was done by the Commonwealth Government when it appointed the present Advisory Council (*Gazette* of 16th March, 1916, No. 35) ; but it is probable that it will give place before long to a Commonwealth Institute of Science and Industry to be established by Act of Parliament with similar functions but fuller powers, as advised in the report of the Conference convened by the Prime Minister last January.

Finally, the Committee note with full approval the conditions laid down in paragraph 7 of the Memorandum as necessary for the successful working of any such body or agency, viz. :—

- (a) that it shall be supported by the resources and influence of the Ministry ;
- (b) that it shall have really responsible functions and substantial authority of its own ;
- (c) that it shall be at liberty to communicate freely with the corresponding bodies in the United Kingdom and other parts of the Empire, and to negotiate with them in the execution of schemes of research, within the limits of the funds placed at their disposal.

The Committee believes that these conditions are fulfilled by the Constitution of the present Advisory Council, and that they will be fully embodied in that of the future Commonwealth Institute of Science and Industry.

Subjects for which Research Laboratories are provided. (Delete those not provided.)		Names and Qualifications of Officers in Charge.		Names and Qualifications of Subordinate Officers.		Remarks.
1.	Analytical Chemistry	...	..	...
2.	Physical and Electro Chemistry	...	..	...
3.	Organic Chemistry	...	...	...
4.	Bio-Chemistry	...	..	...
5.	Agricultural Chemistry	...	...	...
6.	Metallurgical Assay	...	..	...
7.	Metallurgy	...	..	...
8.	Physics	...	..	...
9.	Mechanical Engineering	...	..	...
10.	Hydraulic Engineering	...	..	...
11.	Electrical Engineering	...	..	...
12.	Petrology and Mineralogy	...	..	...
13.	Economic Bacteriology	...	...	...
14.	Economic Botany	...	...	...
15.	Economic Zoology and Parasitology	...	...	...
16.	Veterinary Pathology	...	...	...
17.	Other Subjects, as specified below :—					

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

EXECUTIVE COMMITTEE.

314 ALBERT STREET,

East Melbourne, 1916.

To the Public Service Commissioner,

DEAR SIR,

My committee is engaged in the enquiry as to the prospects of a future supply of fully qualified scientific investigators such as may be required in connection with researches initiated by this Council. A constant supply of such men is an essential factor in any national attempt scientifically to re-organize our industries and to find new fields for the profitable utilization of our raw materials.

We know that you can give us information of great value bearing upon the above enquiry, and shall therefore be obliged if you will furnish my committee with all possible information upon the following points. I may add that we are directing similar enquiries to the Universities and Higher Technical Schools of Australia.

1. Any regulations imposed by you as to the admission and training of students, cadets, or junior technical officers in any of the scientific branches of the service under your control.
2. The encouragement given to such juniors to pursue a definite course of training in pure science in any of the recognized higher educational institutions while they are at the same time gaining technical knowledge required by their Departmental work.
3. What inducements, if any, are held out to officers in the Service to encourage them in the development of their faculties of research, and how far the professional officers controlling such departments are induced to encourage original work on the part of their staffs, either outside of the strict routine work of their officers or suggested thereby.

Yours faithfully,

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

EXECUTIVE COMMITTEE.

314 ALBERT STREET,

EAST MELBOURNE.

The Chairman, State Committee.....

DEAR SIR,

In connexion with the work which this Committee has been called upon to initiate, it has been found that a preliminary necessity is what may be called an Industrial Census of the Commonwealth, comprising a catalogue of Australian Industries (both primary and secondary), with particulars as to their distribution, extent, and relative importance, and also to obtain so far as may at present be possible some account of the difficulties and technical and manufacturing problems connected with these industries towards the removal of which this Committee may be of assistance.

In both these matters it is felt that your Committee is possessed of that intimate and local knowledge which is desired, and I am instructed to solicit your early and earnest assistance in getting this information together. Returns obtained from the Commonwealth Statistician include many industries which it is obvious are of such a nature that they will never be likely to require assistance from this Committee, and all such should be omitted. In this direction, the technical knowledge of your Committee would be of the utmost value in expunging from the complete Statist's lists any branches of industry which need not be considered.

It is suggested that the assistance of the State Statisticians be sought by you, and a return compiled setting forth the various industries *in their order of local importance*, and it is also recommended that as a basis of classification should be taken:—For Secondary Industries: Table 145, page 92, of Bulletin No. 8 (Production), Commonwealth Bureau of Census and Statistics (1903–1913); for Primary Industries: the Divisions II. to VII. inclusive contained in the first paragraph of the preface to the same Bulletin.

The particular headings under which it is desired that the information may be set forth in the return are as follow:—

INDUSTRIAL CENSUS.

1. Nature of the Industry.
2. Distribution (Localities).
3. Number and names of firms engaged therein.
4. Capital invested.

Note.—This is desirable if obtainable, but the Committee do not press for it where objection may be raised to giving this information. It may be found sufficient to obtain the particulars under the next heading.

5. Amount of wages paid.
6. Number of men and women employed.

PROBLEM CENSUS.

1. General difficulties or disabilities which affect the development and progress of any existing industry as a whole.

Note.—This should be shown opposite each of the industries included in the above return.

2. Any such difficulties which may have been encountered by particular firms engaged in a given industry.

It is recognised that this may take considerable time to collect, and it is requested that the return asked for above should not be delayed on this account, but that this information may be forwarded from time to time as available.

3. A return showing opportunities which in the opinion of your Committee exist in your State for the establishment of hitherto undeveloped industries either—

(a) Primary, such as the production of raw products not yet grown or utilization of products not yet turned to account.

(b) Secondary, such as the utilization of by-products from existing industries.

4. A statement of national problems deserving the attention of the Committee. As an illustration of what is required under this heading, I may state that the Committee has already been asked to consider such questions as the eradication of the prickly pear, the blow-fly pest in sheep, and the introduction of a mechanical cotton picker.

In connexion with your statement with regard to problems, it is particularly desired that you will give as full information as possible as to any investigations, researches, or tests which may have already been undertaken in connexion therewith, and state where the results of such investigations may be obtained and studied. This would include data as to any collection made of information bearing upon the subjects referred to.

(Sgd.) A. GARDINER, Chairman,
Commonwealth Advisory Council of Science and
Industry.

COMMONWEALTH OF AUSTRALIA.

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.
EXECUTIVE COMMITTEE.

314 ALBERT STREET,

EAST MELBOURNE.

The Chairman,

State Committee

DEAR SIR,

I forward you the following statement as to the decision which has been arrived at by the Government concerning the formation of State Committees of the above Council and their relation thereto, and the Executive trust that they may rely upon your earnest and valuable help in giving this organization vital force and effectiveness. The Commonwealth Government are requesting the Governments in the various States which have at present less than three representatives to nominate sufficient additional members to give at least that number of representatives on the Advisory Council.

2. These representatives form in each State a State Committee, together with any other Associate Members appointed on the nomination of State Governments. These Associate Members of the State Committees shall not be members of the Advisory Council. The State Committee shall be called together by its Chairman.

3. The local State Committee shall select as its Chairman one of its members on the Advisory Council.

4. The Chairman of each State Committee shall be *ex officio* a member of the Executive Committee.

With regard to that portion of paragraph No. 2 above which refers to the appointment of Associate Members, I should like to draw your attention to the special provisions laid down by the Commonwealth Government. Such Associate Members are intended to be persons of such special knowledge as may be of particular service to the State Committee in connexion with any special question with which they may be dealing at the time, and they will be associated with the Committee for that special service. The Commonwealth Government have stated that :—

“The Executive of the Advisory Council is asked to indicate to the Commonwealth Government the branch of science or industry which the Committee or Sub-Committee is to deal with; that the Commonwealth Government will then communicate with the State Governments as to any persons they may desire to nominate; and that the Commonwealth Government will appoint such Associate Members.”

The Executive will depend in this matter entirely upon the recommendations of the State Committees, and you are, therefore, requested to convey to the Executive, from time to time, the nature of any subject being dealt with, and in connexion with which your Committee is considered as requiring augmentation.

Yours faithfully,

COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

MEMORANDUM ON THE SUGGESTIONS MADE BY THE GOVERNMENTS OF VICTORIA AND NEW SOUTH WALES FOR MAKING THE SCHEME FOR THE ORGANIZATION AND DEVELOPMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH APPLICABLE TO THE WHOLE EMPIRE.

1. The Committee of the Privy Council for Scientific and Industrial Research have considered the papers communicated to them by the Secretary of State for the Colonies on the 23rd November, 1915 and the 3rd January, 1916, including memoranda by the Minister of Public Works of Victoria, and by the Honorable Premier for New South Wales. It is suggested in these memoranda that the scheme described in the White Paper issued by Mr. Arthur Henderson on the 23rd July, 1915, [Cd. 8005], and subsequently embodied in the Order in Council of the 28th July, 1915 (which is reprinted as an appendix to this memorandum), should be extended and made applicable to the Overseas Dominions, or even to the Empire as a whole.

2. In the memorandum by the Minister of Public Works of Victoria, special stress is laid on the statement made in paragraph 3 of the White Paper that—

“ it is clearly desirable that the scheme should operate over the Kingdom as a whole with as little regard as possible to the Tweed and the Irish Channel. The research done should be for the Kingdom as a whole, and there should be complete liberty to utilize the most effective institutions and investigators available, irrespective of their location in England, Wales, Scotland, or Ireland.”

The Committee of Council have no hesitation in expressing their concurrence in the view that the principle of the passage above cited is capable of a much wider application, and so far as in them lies they are prepared to co-operate cordially with the Secretary of State in promoting such an arrangement between the Mother Country and the Overseas Dominions as would secure the effective application of the principle throughout the Empire. A complete and effective system of research implies the power to carry out each piece of work in the place where the conditions are most favorable and where it can be performed most thoroughly, quickly, and economically. It is obvious that reciprocal arrangement by which the scientific and industrial resources of the Mother Country in men, material, and equipment, could be made available for a research in which any of the Dominions was primarily interested, and which conversely would place the resources of the Overseas Dominions at the Disposal of the Mother Country and of each other, would greatly augment the aggregate research capacity of the Empire and enhance the productivity of its industries.

3. The simplest form of Imperial co-operation would be an arrangement by which one Government (or some administrative body acting under its authority) would act as the agent of another Government for the purpose of arranging, carrying out, and supervising a specific research, the entire cost being borne by the Government initiating the research. It is not outside the existing powers of the Committee of the Privy Council to aid a research intended to benefit a British industry, even though the research may be conducted beyond the borders of the United Kingdom. For instance, the best means of recovering a metal found in one of the Overseas Dominions and needed for the production of some new alloy required by the British Metallurgical or Engineering Industry, might form the subject of a research conducted in that Dominion at the

instance and at the cost of the Committee of Council. For this purpose their Advisory Council would naturally try to find some body or institution in the Dominion willing, as the Committee's agent, to arrange for and supervise the actual execution of the research. Conversely there is no reason why the Committee of Council or their Advisory Council should not act as the agent for an Overseas Government (or for any body or institution acting under the authority of that Government), for the purpose of arranging and carrying out on its behalf and at its cost any research which could more conveniently or effectively be conducted in the Mother Country. For instance, it may be worth while for an Overseas Dominion to defray the cost of a research in the Mother Country into the best method of utilizing an earth or metal which is found in the Dominion but for which there is not at present a sufficient market in the Mother Country, with a view to creating such a market.

4. If, however, an effective agency arrangement were established between different parts of the Empire, it is highly probable that this relation would quickly develop into a more intimate and a more highly organized relation. The scope and methods of modern scientific research, especially when it is directed to the solution of the practical problems of trade and industry, are such as often to require the combined efforts of many workers in many places, involving a co-ordinated division of labour, and a series of investigations into problems arising at many points in the process between the raw material and the finished product. Where the raw material is produced, and especially where it is grown, in one part of the world and manufactured in another, a satisfactory solution of the series of problems with which the industry is confronted will often require concurrent and concerted investigation in both countries. For instance, wheat, cotton, silk, rubber, and wool offer a number of distinct though related problems which intimately affect more than one of the constituent parts of the Empire, and which can be most effectively dealt with by simultaneous and co-ordinated investigation in different parts of the world. In such cases, moreover, it is not at all likely that the commercial interests of the two countries in the results of the different parts of the research will be so distinct as to admit of separate valuation of and separate payment for the work actually done for each country. The character of modern organized research, and the character of modern commerce and industry, are in fact such as to render it almost inevitable that a relation which starts as one of reciprocal agency between different parts of the Empire should lead to a more definitely co-operative relation of "joint venture" or "limited partnership." Under such an arrangement two or more parts of the Empire would combine to frame a scheme for the investigation of a specific problem in which they were all jointly interested, would continue in agreed proportions to the cost of the whole work, and would arrange between themselves for the distribution of the work among the laboratories, factories, &c., at the disposal of the contributors, for the supervision of the work and for the collection, statement, and use of the results achieved.

5. It is not inconceivable that in the future the relations of agency or "joint venture" may lead to a still more extensive and comprehensive partnership or union of interests. The White Paper already referred to declares, at the end of paragraph 3, with reference to the United Kingdom, that "there must be a single fund for the assistance of research under a single responsible body." The question whether it would be practicable to extend this principle to the whole Empire by the constitution of a Central Body for the purpose of administering a common fund supported by contributions from the United Kingdom and Overseas Dominions, raises issues with which the Committee of Council are not competent to deal. The "pooling" or consolidation of the resources of the Empire for the purposes of scientific research is a stimulating ideal, but though pure science is cosmopolitan and disinterested, it is in its application to trade and industry inevitably affected by the divergent commercial interests of individuals and Governments, and the wide separation in space and the great diversity of the components of the British Empire, are still material considerations of which the full account must be taken in thinking of any scheme for unified administration.

6. The Committee of Council, however, believe that even at the present time when the energies of the Empire are so pre-occupied by the war, it is not only possible but very desirable to make an advance in the direction suggested by the Governments of Victoria and New South Wales.

It may not be possible during the war to undertake, either at home or in the Overseas Dominions, any researches involving the concerted work of a large number of trained researchers, or the provision of extensive plant and equipment. On the other hand the Committee of Council are more than ever convinced that during the war it is essential to prepare and test, if only on a relatively small scale, an organization by which the scientific resources of the Empire can be mobilized on a large scale immediately the war is over. The success of anything like an Imperial Scheme of Research must ultimately depend at least as much upon the skill, foresight, and care with which it is managed as upon the zeal and goodwill of the Governments, universities, and industries, which co-operate in it; and it would be very imprudent to wait until the demand has become heavy and urgent in the hope of then improvising a satisfactory system of management.

7. The Committee, therefore, suggest that if the general proposal commends itself, each Overseas Government which is willing to enter into a co-operative arrangement should, as a first step and at an early date, constitute some body or agency having functions analogous to those of the Advisory Council which acts for the United Kingdom.

The Committee of Council have, of course, no intention of suggesting that the particular arrangement adopted for the United Kingdom should be taken as a model by other parts of the Empire. The Committee of Council as originally constituted consists of six Ministers *ex-officio*, and three ex-Ministers. This body is ultimately responsible for asking Parliament to furnish the necessary funds and for approving their expenditure. It is an essential part of the scheme that all proposals for research shall stand referred to an Advisory Council which is a relatively small body, mainly consisting of eminent scientific men and men actually engaged in industries dependent upon scientific research, and that this Council shall take full responsibility for the scientific and technical soundness of all research proposals recommended by them for State assistance.

In the case of the Overseas Dominions the precise relation of any new body or agency to the Central or the State or Provincial Government, or to a particular Ministry, must obviously depend on local conditions and local preferences. It is, of course, assumed that it would be supported by the resources and influence of the Ministry of Commerce, as in the United Kingdom the resources and influence of the Board of Trade are available for working the scheme of research in its commercial and industrial relations.

The Committee of Council, however, venture to lay stress upon two points. First, any bodies or agencies instituted for the purpose should, under their respective Governments, have really responsible functions and substantial authority. The several bodies moreover should be at liberty to communicate freely with one another, and should, within the limits of the funds placed at their disposal, be empowered to negotiate with one another for the formulation and execution of schemes of research. Secondly, a close connexion should be maintained between these bodies and the public educational systems and institutions of their respective countries. It is obvious that the work of Universities and other institutions for advanced scientific and technological education will both affect and be affected by a State scheme of research, and that the systematic development of research must ultimately depend upon an adequate supply of men and women who are fitted by their training to undertake it. So far as the extended scheme of research involves consideration of the educational problems of different parts of the Empire, it would possibly form an appropriate subject for consideration at the next Imperial Education Conference and the next Conference of the Universities of the Empire.

8. It is too soon for the Committee of Council to speak as to the working of the scheme which has been established in the United Kingdom. One of the most important functions of the Advisory Council is to promote a better understanding and a closer union between men engaged in science and in industry. Considerable use has already been made by the Advisory Council of sub-committees reinforced by suitable experts in particular branches of science or industry, such as were contemplated by paragraph 8 of the White Paper, and arrangements are now being made to give effect to the principle of paragraph 7 of the White Paper by setting up certain representative Standing Committees for the great scientific industries of Engineering, Metallurgy, and Mining.

9. The Committee of Council would gladly co-operate with the Secretary of State in establishing and conducting any central organization which it may be found desirable to set up in London for the purpose of facilitating and carrying on the business of an Imperial Scheme of Research. Some kind of central office, information bureau, or clearing house would be required, and, to start with, it might be possible to use, and, as occasion requires, to extend for this purpose the staff of the Advisory Council. A beginning has already been made by the Advisory Council in the compilation of a Register of Research, the scientific and industrial utility of which would be obviously greatly increased if its scope were extended to all parts of the Empire.

10. No reference has been made in this memorandum to the research work which is already done on behalf of the Overseas Dominions and Exchequer aided Colonies and Protectorates by such institutions as the National Physical Laboratory and the Imperial College of Science and Technology, as well as by the Laboratory of the Imperial Institute. Close relations between the Advisory Council and these institutions are being established, and it is of course assumed that in any extension of the Research Scheme to the Overseas Dominions full use would be made of the facilities offered by these and similar institutions, and of the experience possessed by the bodies and persons concerned in carrying on their work.

Office of the Board of Education,
Whitehall, London, S.W.

2nd March, 1916.

CREWE,

Lord President.

ARTHUR HENDERSON,
President of the Board of Education.

L. A. SEBY-BIGGE,
Special Secretary of the Committee.

SCHEME FOR THE ORGANIZATION AND DEVELOPMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

1. There is a strong consensus of opinion among persons engaged both in science and in industry that a special need exists at the present time for new machinery and for additional State assistance in order to promote and organize scientific research with a view especially to its application to trade and industry. It is well known that many of our industries have since the outbreak of war suffered through our inability to produce at home certain articles and materials required in trade processes, the manufacture of which has become localized abroad, and particularly in Germany, because science has there been more thoroughly and effectively applied to the solution of scientific problems bearing on trade and industry and to the elaboration of economical and improved processes of manufacture. It is impossible to contemplate without considerable apprehension the situation which will arise at the end of the war unless our scientific resources have previously been enlarged and organized to meet it. It appears incontrovertible that if we are to advance or even maintain our industrial position we must as a nation aim at such a development of scientific and industrial research as will place us in a position to expand and strengthen our industries and to compete successfully with the most highly organized of our rivals. The difficulties of advancing on these lines during the war are obvious and are not underestimated, but we cannot hope to improvise an effective system at the moment when hostilities cease, and unless during the present period we are able to make a substantial advance we shall certainly be unable to do what is necessary in the equally difficult period of reconstruction which will follow the war.

2. The present scheme is designed to establish a permanent organization for the promotion of industrial and scientific research.

It is in no way intended that it should replace or interfere with the arrangements which have been or may be made by the War Office or Admiralty or Ministry of Munitions to obtain scientific advice and investigation in connexion with the provision of munitions of war. It is, of course, obvious that at the present moment it is essential that the War Office, the Admiralty, and the Ministry of Munitions should continue to make their own direct arrangements with scientific men and institutions with the least possible delay.

3. It is clearly desirable that the scheme should operate over the Kingdom as a whole with as little regard as possible to the Tweed and the Irish Channel. The research done should be for the Kingdom as a whole, and there should be complete liberty to utilize the most effective institutions and investigators available, irrespective of their location in England, Wales, Scotland, or Ireland. There must therefore be a single fund for the assistance of research, under a single responsible body.

4. The scheme accordingly provides for the establishment of—

- (a) A Committee of the Privy Council responsible for the expenditure of any new moneys provided by Parliament for scientific and industrial research.
- (b) A small Advisory Council responsible to the Committee of Council and composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research.

5. The Committee of Council will consist of the Lord President, the Chancellor of the Exchequer, the Secretary for Scotland, the President of the Board of Trade, the President of the Board of Education (who will be Vice-President of the Committee), the Chief Secretary for Ireland, together with such other Ministers and individual Members of the Council as it may be thought desirable to add.

The first non-official Members of the Committee will be :—

The Right Hon. Viscount Haldane of Cloan, O.M., K.T., F.R.S.,
The Right Hon. Arthur H. D. Acland, and
The Right Hon. Joseph A. Pease, M.P.

The President of the Board of Education will answer in the House of Commons for the sub-head on the Vote, which will be accounted for by the Treasury under Class IV., Vote 7, "Scientific Investigations, &c."

It is obvious that the organization and development of research is a matter which greatly affects the public educational systems of the Kingdom. A great part of all research will necessarily be done in Universities and Colleges which are already aided by the State, and the supply and training of a sufficient number of young persons competent to undertake research can only be secured through the public system of education.

6. The Primary functions of the Advisory Council will be to advise the Committee of Council on—

- (i) proposals for instituting specific researches ;
- (ii) proposals for establishing or developing special institutions or department of existing institutions for the scientific study of problems affecting particular industries and trades ;
- (iii) the establishment and award of Research Studentships and Fellowships.

The Advisory Council will also be available, if requested, to advise the several Education Departments as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research.

Arrangements will be made by which the Council will keep in close touch with all Government Departments concerned with or interested in scientific research and by which the Council will have regard to the research work which is being done or may be done by the National Physical Laboratory.

7. It is essential that the Advisory Council should act in intimate co-operation with the Royal Society and the existing scientific or professional associations, societies, and institutes, as well as with the Universities, Technical Institutions, and other Institutions in which research is or can be effectively conducted.

It is proposed to ask the Royal Society and the principal scientific and professional associations, societies, and institutes to undertake the function of initiating proposals for the consideration of the Advisory Council, and a regular procedure for inviting and collecting proposals will be established. The Advisory Council will also be at liberty to receive proposals from individuals and themselves to initiate proposals.

All possible means will be used to enlist the interest and secure the co-operation of persons directly engaged in trade and industry.

8. It is contemplated that the Advisory Council will work largely through Sub-Committees reinforced by suitable experts in the particular branch of science or industry concerned. On these Sub-Committees it would be desirable as far as possible to enlist the services of persons actually engaged in scientific trades and manufactures dependent on science.

9. As regards the use or profits of discoveries, the general principle on which grants will be made by the Committee of Council is that discoveries made by institutions, associations, bodies, or individuals in the course of researches aided by public money shall be made available under proper conditions for the public advantage.

10. It is important in order to secure effective working that the Advisory Council should be a small body, but it is recognised that, even if full use is made by the Council of its power to work through reinforced Sub-Committees, its membership may be found inadequate to do justice to all the branches of industry in which proposals for research

may be made or to the requests of other Government Departments for assistance. It is therefore probable that it will be found necessary to strengthen the Council by appointing additional Members.

The first Members of the Council will be—

The Right Hon. Lord Rayleigh, O.M., F.R.S., LL.D.

Mr. G. T. Beilby, F.R.S., LL.D.

Mr. W. Duddell, F.R.S.

Prof. B. Hopkinson, F.R.S.

Prof. J. A. McClelland, F.R.S.

Prof. R. Meldola, F.R.S.

Mr. R. Threlfall, F.R.S.

With Sir William S. McCormick, LL.D., as Administrative Chairman.

11. The Advisory Council will proceed to frame a scheme or programme for their own guidance in recommending proposals for research and for the guidance of the Committee of Council in allocating such State funds as may be available. This scheme will naturally be designed to operate over some years in advance, and in framing it the Council must necessarily have due regard to the relative urgency of the problems requiring solution, the supply of trained researchers available for particular pieces of research, and the material facilities in the form of laboratories and equipment which are available or can be provided for specific researches. Such a scheme will naturally be elastic, and will require modification from year to year; but it is obviously undesirable that the Council should live "from hand to mouth" or work on the principle of "first come first served," and the recommendations (which for the purpose of estimating they will have to make annually to the Committee of Council) should represent progressive instalments of a considered programme and policy. A large part of their work will be that of examining, selecting, combining, and co-ordinating rather than that of originating. One of their chief functions will be the prevention of overlapping between institutions or individuals engaged in research. They will, on the other hand, be at liberty to initiate proposals and to institute inquiries preliminary to preparing or eliciting proposals for useful research, and in this way they may help to concentrate on problems requiring solution the interest of all persons concerned in the development of all branches of scientific industry.

12. An Annual Report, embodying the Report of the Advisory Council, will be made to His Majesty by the Committee of Council and laid before Parliament.

13. Office accommodation and staff will be provided for the Committee and Council by the Board of Education.

ARTHUR HENDERSON.

23rd July, 1915.

COMMONWEALTH OF AUSTRALIA.

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

SECOND REPORT OF EXECUTIVE COMMITTEE.

EXECUTIVE COMMITTEE :

Chairman : Senator A. GARDINER, Vice-President of Executive Council.

Deputy Chairman : Professor D. ORME MASSON, M.A., D.Sc., F.R.S.

G. D. DELPRAT, Esq.

Professor T. R. LYLE, M.A., Sc.D. F.R.S.

E. A. MANN, Esq., F.I.C.

A. B. PIDDINGTON, Esq., K.C.

Professor R. D. WATT, M.A., B.Sc.

Ex Officio Members :

Chairman of New South Wales Committee : F. LEVERRIER, Esq., K.C.

Chairman of Victorian Committee : Professor T. R. LYLE, M.A., F.R.S.

Chairman of Queensland Committee : Professor ALEX. J. GIBSON, M. Inst.C.E.

Chairman of South Australian Committee : Professor E. RENNIE, D.Sc.

Chairman of Western Australian Committee : Professor J. W. PATERSON.

Chairman of Tasmanian Committee (not appointed).

314 Albert-street, East Melbourne,
1st August, 1916.

Since the date of its First Report (21st June) the Executive Committee has held eleven meetings, and has made considerable progress in some of the inquiries there referred to and also in connexion with other important problems. It desires, therefore, to submit this Second Report for the information of the Advisory Council at the meeting which is to be held on the 4th instant.

FORMATION OF STATE COMMITTEES.

In further pursuance of the policy recommended by the Advisory Council and adopted by the Federal Government, additional members of the Advisory Council have been appointed, so as to provide for the formation of State Committees in South Australia and Western Australia, as well as in New South Wales, Victoria, and Queensland, where similar committees had already been constituted prior to the 21st of June. In most of these States, moreover, Associate Members have been appointed or nominated for appointment, so as to strengthen the Committees in special branches of Science or Industry. Unfortunately no State Committee has yet been formed in Tasmania, though it is understood that the Government of that State received from the Federal Government the same invitation to make the necessary nominations as was given to other States. It is much to be hoped that a Tasmanian Committee will be formed soon—not merely because it is desirable to complete the scheme of Committees designed by the Advisory Council, but also because Tasmania, with its great hydro-electric power installation, bids fair to become an important centre of Australian industry.

The State Committees, as at present constituted, are as follows :—

New South Wales :

Dr. Elliott.	A. B. Piddington, Esq., K.C.
Professor C. E. Fawsitt (Hon. Secretary).	Professor R. D. Watt.
F. B. Guthrie, Esq.	Hon. Minister for Agriculture (<i>ex officio</i>).
F. Leverrier, Esq., K.C. (Chairman).	F. Trivett, Esq. (Associate Member).

Victoria.

W. T. Appleton, Esq.	Hon. Geo. Swinburne.
D. Clark, Esq.	W. P. Wilkinson, Esq.
G. D. Delprat, Esq.	Hon. Minister for Agriculture (<i>ex officio</i>).
W. Russell Grimwade, Esq.	A. M. Laughton, Esq. (Associate Member).
J. M. Higgins, Esq.	A. E. V. Richardson, Esq. (Associate Member).
Professor T. H. Laby.	A. Millington, Esq. (Secretary).
Professor T. R. Lyle (Chairman).	
Professor D. Orme Masson.	

Queensland.

G. Bunning, Esq.	W. R. Crampton, Esq. (Associate Member).
Professor A. J. Gibson (Chairman).	Dr. A. J. Gibson (Associate Member).
J. B. Henderson, Esq.	J. Gibson, Esq. (Associate Member).
Dr. H. C. Richards (Hon. Secretary).	F. Robinson, Esq. (Associate Member).
Hon. Minister for Agriculture (<i>ex officio</i>).	

South Australia.

G. Brookman, Esq.	Professor E. Rennie (Chairman).
W. W. Forwood, Esq.	Hon. Minister for Agriculture (<i>ex officio</i>).
W. A. Hargreaves, Esq.	

Western Australia.

E. A. Mann, Esq.	Hon. Minister for Agriculture (<i>ex officio</i>).
Professor J. W. Paterson (Chairman).	(Associate Members nominated.)
J. W. Sutherland, Esq.	

EXECUTIVE STAFF.

A large number of applications (40) were received in response to the advertisement for an Abstractor, which was referred to in the first Report. After consideration, the Executive Committee appointed Mr. W. B. Alexander, M.A. (Camb.), Keeper of the Department of Biology in the Western Australian Museum. Mr. Alexander took up his duties on 20th July, and is now engaged in preparing reports and abstracts on questions referred to him by the Executive Committee. The Chief Librarian of the Melbourne Public Library (Mr. E. La T. Armstrong) has very kindly placed a special room there temporarily at the service of the Committee for this purpose.

Mr. Gerald Lightfoot, M.A. (Camb.), of the Federal Statistician's Department, who was Secretary of the Committee of Conference which drafted the scheme of the Institute, and who afterwards visited America and Great Britain with the Prime Minister for the purpose of inquiring into similar activities there, has quite recently returned to Melbourne.

COLLECTION OF DATA.

Numerous replies have been received to the circular letters addressed by the Executive Committee to State Departments, Universities, and Higher Technical Schools, and to the State Committees of the Advisory Council, with a view to compiling information as to Australian industries, problems arising in connexion with them, the laboratories and *personnel* now available for research, and the facilities for the education of future investigators. The Committee desires to acknowledge gratefully the valuable service thus rendered. The returns are not yet complete, the collection of data necessarily taking time; but it is hoped soon to have such a full and properly classified body of information as must greatly aid the work of the Advisory Council and of the future Institute.

In this connexion the Executive Committee desires to express its thanks to the Sydney Section of the Society of Chemical Industry for a valuable Directory of Australian Chemical Manufacturers, which it has compiled and handed over on the understanding that the Committee will print it and render it available for those to whom it may be useful. The Directory will be reprinted from time to time, all necessary additions and amendments being incorporated.

VISITS OF THE EXECUTIVE COMMITTEE TO OTHER STATES.

Reference was made in the First Report to the desire of the Executive Committee most of whose members reside in Melbourne, to visit other States and thus to get into direct touch with the local Committees of the Advisory Council and with other representatives of Science and of Industry. In pursuance of this plan, the Committee has recently spent a week (20th to 26th July) in Sydney. While there, it held a meeting which was attended by the Chairman (Mr. Leverrier) and the Hon. Secretary (Professor Fawsitt) of the New South Wales Committee, and at which much useful work was done that required their presence. The Committee had the privilege also of consulting with the Acting Premier (Mr. Cann) and other members of the State Ministry, and of receiving their assurance of cordial sympathy with the work of the Advisory Council, and a promise by the Acting Premier that the Government would place at the service of the Advisory Council the resources of the various State Departments. Visits were paid to the University, the Technical College, the Technological Museum, the Botanic Gardens, the Department of the Government Entomologist, and some of the leading chemical industries, and in each case much valuable information was obtained as to the work in progress. The opportunity was taken of arranging for the appointment of certain special Research Committees which will be centred in Sydney. These are referred to in the sequel.

The Committee, after this experience, feels that such visits to other States are so instructive and useful that they are indeed indispensable, and it proposes to visit Queensland and other States in turn as soon as may be practicable.

SPECIAL PROBLEMS.

In connexion with most of the problems referred to in the First Report, the Executive Committee has since obtained fuller information from experts, either by personal interviews or by written reports. Several other problems have also received attention. In some cases no definite course of action has yet been adopted, but in others provision has been made for systematic research by Special Committees of two or more experts, who will receive grants from the fund at the disposal of the Executive for the payment of assistants and other working expenses.

The Special Committees already appointed are as follows :—

1. *Ferro Alloys*.—As stated in the First Report, Mr. A. J. Higgin and Mr. E. B. Brown were appointed to carry on the work begun in the Metallurgy Laboratories of the University of Melbourne at the instigation of the Federal Munitions Committee, and a grant of £150 was made to them to cover new working expenses. The work is proceeding, but will make more rapid progress when a qualified assistant has been found to devote his whole time to it. The Committee has been promised an additional grant for this purpose. The production of such alloys as ferro-chrome and ferro-tungsten is a necessary preliminary to the manufacture of high-speed tool steels, which are not yet made in Australia. Should such manufacture be undertaken here, it will be an advantage to have men on the spot who have acquired scientific and experimental knowledge of the subject. Moreover, the problem of special iron alloys and of the relations between their composition and physical properties is far from being worked out; and there is ample room for an extended research on this subject here, as well as in England and other countries, where subsidized investigations are in progress. The present work may perhaps lead later to such an extended research.

2. *Manufacture of Chemicals.*—The Special Committee which was appointed shortly before the date of the First Report consists of Professor Masson, Mr. E. A. Mann, and Mr. V. G. Anderson. Its function is to institute inquiries as to the possibility of manufacture in Australia of chemicals now imported and to report to the Executive Committee, which will take such action in particular cases as may seem desirable. A considerable amount of information has been collected, though the work of the Special Committee has been somewhat delayed by the illness of one of its members.
3. *Alumite.*—This is a mineral which occurs in large quantities in New South Wales, South Australia, and other parts of Australia, as well as in America and elsewhere, and which has commercial value as a source of potassium sulphate and of alumina. Since the German supplies of potash salts were cut off by the war, alumite has, of course, acquired a greatly enhanced value, and it is now being purchased at £10 a ton (in Adelaide) for export; but its treatment in Australia has not been attempted. The main lines of the processes used elsewhere are known, but experimental investigation of their details is required. The Executive has therefore, after inquiry, appointed Professor Masson, Mr. A. J. Higgin, and Mr. V. G. Anderson as a Special Committee for this purpose, with Mr. F. W. Janes to carry out laboratory trials under their direction at a salary of £30 per month. A further grant of £100 for working expenses has been voted. The work will probably be done in the University of Melbourne.
4. *Posidonia Fibre.*—This is a vegetable fibre which occurs in immense quantities in deposits, overlaid by a shallow covering of sand, at Wood's Point, Spencer's Gulf. It has been reported on by the Imperial Institute, London, and by a committee of the Sydney Section of the Society of Chemical Industry. It contains a large percentage of cellulose, and has been suggested as a possible substitute for cotton in the manufacture of nitro-cellulose. There are strong reasons against the adoption of any such substitute for propulsive explosives; but there are other possible uses to which *Posidonia Fibre* may be put, and it is known that it was, before the war, exported to Germany, and there specially treated for use in textile manufacture and perhaps for other purposes. There is, therefore, a *prima facie* case for a detailed research into the chemistry and physics of this material, with a view to establishing, if practicable, a native industry. The Executive has, therefore, invited the following to form a Special Committee, and is prepared to consider any application they may make for financial aid in the investigation:—Professor Rennie and Mr. Hargreaves (South Australia), and Professor Read and Mr. H. G. Smith (Sydney).
5. The laws governing the *Mode of Occurrence of Gold in Quartz* are far from being fully understood, and the evidence given by Professor Skeats, of the University of Melbourne, has satisfied the Executive that systematic investigation by a competent geologist will probably throw such further light on this question as to aid in the localization of payable gold and thus cheapen deep prospecting, and otherwise benefit one of Australia's principal industries. The Bendigo field has been selected for investigation in the first instance, and the results obtained there will help to decide whether further researches elsewhere should be undertaken. The work has been intrusted to a Special Committee, consisting of Professor Skeats (chairman), Mr. H. Herman, B.C.E., M.M.E. (Victorian Government Geologist), Mr. E. C. E. Dyason, B.Sc., B.M.E., and Mr. F. L. Stillwell, M.Sc., lately Geologist to the Australian Antarctic Expedition. Mr. Stillwell, who will receive a salary of £400 for one year, is to give his whole time to the work, and has been liberated for this purpose from the A.I.F. by order of the Minister for Defence.

6. *The Tick Pest in Cattle*.—This is one of the most important problems affecting the pastoral industry, especially in Queensland and New South Wales. After consultation with various experts in veterinary science, the Executive has decided to appoint a Special Committee to review the whole position, present and future, and to make representations both as to further scientific research and as to immediate remedial or preventive measures, whether by legislation or otherwise. This Committee will include Professor Stewart (Chairman) and Dr. Dodd, of the Sydney University, who have consented to act, and, it is hoped, Dr. Gilruth, Administrator of the Northern Territory, the Chief Inspectors of Stock of New South Wales, Queensland, and Victoria, Mr. W. H. Clarke, and one or more other members to be nominated by the Queensland State Committee. It is proposed that all members shall attend a first meeting in Sydney at a date to be fixed, after which they can probably discuss matters by correspondence.
7. *The Nodule Disease in Cattle*.—This problem is in a different position from the last, inasmuch as the life-history of the parasite is as yet not fully known, and various investigators have put forward different unproved hypotheses as to the intermediate host. It is absolutely necessary that all such questions should be cleared up by systematic research before the proper preventive measures can be decided on. The Executive has therefore decided to invite the chief Australian investigators who have already devoted attention to this subject to join a Special Committee, which will hold a first meeting in Sydney and thereafter consult by correspondence, and which will plan a campaign of research. The Executive will consider any application for financial assistance. The Committee will probably consist of Dr. Dodd (Chairman), Dr. Cleland and Dr. S. Johnston, of Sydney, Dr. Breinl and Dr. Nichol, of the Institute of Tropical Diseases, Queensland, Dr. Georgina Sweet, of Melbourne, Dr. J. A. Gilruth, and Mr. W. H. Clarke. Some of these have accepted, and replies are awaited from the others.
8. *Yeasts and Bread-making*.—Dr. H. G. Chapman, M.D. (Melb.), Lecturer on Physiological Chemistry in the University of Sydney, who also has charge of the School of Bakery in the Sydney Technical College, has devoted special attention for some years to the cultivation of various pure yeasts and to their utilization in bread-making. The results already obtained afford hope that it may be found possible so to shorten the period of the maturing of dough as to contribute materially to the solution of labour difficulties that have recently come before the public in connexion with the baking trade. The work is also scientifically and industrially important on other grounds. It is at present retarded by lack of certain apparatus and of a laboratory assistant, and the Executive proposes to give a grant-in-aid of £200, to be administered jointly by Dr. Chapman and Mr. Nangle, Director of the Technical College, Sydney.
9. On the recommendation of the Victorian State Committee, the Executive has decided to appoint a Special Committee to deal with the problem of the *Standardization of Physical Apparatus* for the teaching of science in the technical and other schools and colleges of Australia, and to place at its disposal a skilled draughtsman, who will be paid at the rate current for such work. Hitherto teachers have been dependent mainly on imported apparatus, there has been no guidance as to the best designs except from trade catalogues, and much trouble and waste has arisen through the importation of unsuitable apparatus. Since the war it has become practically impossible to rely upon importation. At all times it is highly inconvenient to depend on a distant source of supply. It is therefore proposed to make working drawings of apparatus specially selected or designed by the Committee,

and to place these at the disposal of all manufacturers in Australia who desire to make use of them. The project is strongly favoured by the authorities of the Victorian Education Department and by others already consulted, and it is hoped that the new standard designs will be welcomed generally in Australian schools and technical colleges. The following will be asked to act on the Special Committee :

Professor Laby (Chairman), Mr. Donald Clark, Mr. W. Kernot, and Mr. W. A. Holmes (Melbourne), Mr. F. Nangle (Sydney), Professor Gibson (Brisbane), Professor K. Grant (Adelaide), Professor Wilshire (Perth).

The Executive has also devoted attention to the following problems, though it does not at present propose to appoint Special Committees or to make research grants in connexion with them :—

10. *The Cultivation of Cotton and the Problem of a Mechanical Cotton Picker.*—Various reports have been received, and the whole question has been referred to the Queensland State Committee.
11. *The Prickly Pear.*—Much information has been collected and tabulated. The Queensland Government has expressed the wish to hand over the whole question of the best method of eradication to the Institute. It is too large an undertaking for the present provisional machinery, but the Institute itself, when formed, may be able to accept the responsibility. In the meantime, the Executive has asked the Queensland State Committee to give special attention to this problem.
12. *The Brown Coal of Victoria.*—The Executive has obtained evidence from Mr. P. G. W. Bayly, Chemist to the Mines Department, as to the past and present investigations undertaken by the Victorian Government. Very possibly some financial assistance may be given by the Executive in the near future.
13. *The Sheep-fly Pest.*—Further evidence has been obtained as to the work in progress in New South Wales and Queensland, and the Executive, when in Sydney, interviewed Mr. Kidd, Chairman of the Pastoralists' Committee (referred to in the First Report), and Mr. Froggatt, Government Entomologist, who is assisting in its inquiries. The problem is one of very great importance to the pastoral industry, and the Executive agrees with the opinion expressed by the above-named gentlemen that it should be undertaken by a Federal authority, such as the future Institute. For the present, however, it is best left to the existing Committee in New South Wales, which has done such excellent work, and which is prepared to continue its labours till the end of the present year.
14. *Wheat Selection and Breeding.*—After consultation with the Ministers and some of the officers of the State Agricultural Departments, the Executive has decided to convene a conference of Wheat Experts, to be held in Melbourne about the end of October, at which there will be discussions as to past, present, and future work on this and allied subjects, especially in reference to the extension of wheat-growing and of mixed farming to more arid regions. An opportunity will also be given the visitors to see, at a suitable season of the year, the experiments in wheat breeding which are being carried out in Victoria under Mr. Richardson's direction. Good work is being done in this field in most of the States, but there is some lack of co-ordination ; and the Executive believes it can help best by promoting free exchange of knowledge and ideas by the various experts who are so keenly working with the same end in view.
15. *Indigenous Grasses and Salt Bushes.*—The selection of those best suited to cultivation, especially in drought districts, is a problem of importance to both the pastoral and the agricultural industries. Much work is being done in this direction in New South Wales by Mr. Breakwell, Agrostologist, and Mr. Maiden, Director of the

Botanic Gardens, Sydney. The Executive has also had interesting reports from Professor Ewart, of Melbourne, and Mr. Turner, of Sydney. With larger means at their disposal, it is probable that the experts who are devoting themselves to this problem could obtain exceedingly valuable results in the course of a few years. Like others referred to above, it is a problem that would be best attacked by a permanent Federal agency, such as the future Institute; but the present Executive may be able, after further inquiry, to give some assistance.

16. *The Standard for Alcoholometry*.—A report on this subject, prepared by Mr. W. R. Grimwade, was forwarded by the Victorian Committee to the Executive, which has in turn forwarded it to the other State Committees for their opinions. Mr. Grimwade makes out a strong case for the abolition of the unscientific and inconvenient “proof gallon” as a basic standard, and for the substitution of a rational system of evaluation of spirits based on the actual percentage of absolute alcohol, as determined by the specific gravity at a known temperature. The improvement would be very considerable, but—as in all such reforms—there may be difficulties in bringing about a change in a long-established system. If the suggestion be approved, some work must be done in the preparation of official tables, and in the designing of a new standard instrument for use by the trade.
17. *Forestry and Timber Industries*.—Since the date of the First Report the Executive has obtained further interesting evidence bearing on the important problems under this head. It is not yet in a position to offer opinions, but hopes to deal with the question in a subsequent report.

CONCLUSION.

The Executive is already in touch with various other problems which it has not yet had time to discuss in detail, but which it hopes to deal with at an early date. From its own experience within the last few weeks, it is convinced that the Commonwealth Institute of Science and Industry is destined to do very important work as an agency for directing research on problems connected with the industries of Australia. Indeed, it may be said with certainty that the Institute’s opportunities of achieving results of public utility will be limited only by the amount of money at its disposal, and by the number of trained scientific investigators available for such work. And this number will increase as openings are created for them by the activity of the Institute—the supply will grow with the demand.

(Signed) ORME MASSON,
Deputy Chairman.



(COMMONWEALTH OF AUSTRALIA.

(ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

3rd :

REPORT

OF THE

EXECUTIVE COMMITTEE

OF THE

COMMONWEALTH ADVISORY COUNCIL OF SCIENCE AND INDUSTRY,

COVERING THE PERIOD FROM THE DATE OF THE APPOINTMENT OF THE EXECUTIVE
COMMITTEE (14TH APRIL, 1916) TO THE 30TH JUNE, 1917.

Prepared under the Authority of

THE RIGHT HON. W. M. HUGHES, P.C., M.P., PRIME MINISTER
(CHAIRMAN OF THE ADVISORY COUNCIL).

1916/17

MELBOURNE, 2ND JULY, 1917.

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REPORT OF EXECUTIVE COMMITTEE, 1916-17.

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COMMONWEALTH OF AUSTRALIA.

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

REPORT OF EXECUTIVE COMMITTEE FOR THE YEAR
1916-17.

PART I.—INTRODUCTION.

1. General.—The Advisory Council was originally appointed by order of the Governor-General in Council on the 16th March, 1916. Since that date certain additional appointments have been made, so that the Council now consists of 35 members representative of both Science and Industry, and includes members from all the Australian States. It is a temporary body, designed to prepare the ground for a proposed permanent Institute of Science and Industry, and to exercise in a preliminary way the functions that will in future belong to the Institute. (See Report of the Drafting Committee of the Conference convened by the Prime Minister in January, 1916.) The chief of these functions are—

- “(i) To consider and initiate scientific researches in connexion with, or for the promotion of, primary or secondary industries in the Commonwealth”; and “(ii) the collection of industrial scientific information and the formation of a Bureau for its dissemination amongst those engaged in industry.”

The Advisory Council itself has held only two meetings, viz., the inaugural meeting on the 14th and 15th April, 1916, and one called on the 4th August, 1916, for the reception of reports. Its work has been done by means of Committees.

Two reports have already been presented by the Executive Committee. The former of these, dated the 21st June, 1916, was issued in pursuance of the resolution passed on the 15th April, 1916, at the first meeting of the Advisory Council, to the effect that the Executive should prepare a Report on proposed organization and future procedure. By the time the second meeting of the Advisory Council was held (4th August, 1916), considerable progress had been made since the date of the first Report. A further Report, dated the 1st August, 1916, was accordingly presented at the second meeting.

The objects for which the temporary organization was established, pending the organization of the proposed permanent Institute of Science and Industry, have now been largely carried out, and as the 30th June, 1917, marks the termination of the first complete financial year for which the Executive Committee has been in existence, the present Report, which surveys the work carried out since its inception, is furnished.

2. The Executive Committee.—In accordance with instructions given by the then Acting Prime Minister, the Advisory Council at its first meeting elected an Executive Committee of six members. It was decided that the Prime Minister, or in his absence the Vice-President of the Executive Council, should be Chairman of the Executive Committee. In addition, it was decided that the Chairman of each State Committee should be *ex officio* a member of the Executive in order to keep the various Committees in touch with one another. Such *ex officio* members were to receive copies of the Executive's minutes, and to keep in touch with it by correspondence, but were not expected to attend its ordinary meetings except when they happened to visit Melbourne. Similarly, the Executive receives copies of the minutes of each State Committee.

The members of the Executive Committee are as follow, viz. :—

MEMBERS OF EXECUTIVE COMMITTEE, 30TH JUNE, 1917.

Chairman : The Rt. Hon. W. M. Hughes, P.C., M.P., Prime Minister ; or, in his absence, Senator the Hon. E. D. Millen, Vice-President of the Executive Council.

Deputy Chairman : Professor D. Orme Masson, M.A., D.Sc., F.R.S.

G. D. Delprat.

Professor T. R. Lyle, M.A., Sc.D.,
F.R.S.

E. A. Mann, F.I.C.

A. B. Piddington, K.C.

Professor R. D. Watt, M.A., B.Sc.

Ex Officio Members (Chairmen of State Committees).

New South Wales : F. Leverrier, K.C.

Victoria : Professor T. R. Lyle, M.A., Sc.D., F.R.S.

Queensland : Major Alex. J. Gibson, A.M.I.C.E.*

South Australia : Professor E. Rennie, M.A., D.Sc.

Western Australia : Professor J. W. Paterson, B.Sc., Ph.D.

Tasmania ; Captain J. H. Butters.

* Mr. J. B. Henderson, F.I.C., is Acting Chairman during Major Gibson's absence in England.

Up to the 30th June, 1917, the Executive Committee had held altogether 92 meetings, its rule being to meet on one or two evenings of each week. Each meeting has occupied, on the average, $2\frac{1}{2}$ hours. The nature of the business transacted will appear below.

3. The State Committees.—At the first meeting of the Advisory Council it was decided that all of its members resident in any one State should form a local Committee to co-operate with the Central Executive, especially in relation to questions involving local industries. By arrangement with the Commonwealth Government, certain additional members of the Advisory Council were added to the original list, so as to insure that there should be at least three such members available for the formation of each State Committee, and it was decided that the chairman of each of these should be *ex officio* a member of the Executive, as explained above. Further procedure was formulated whereby any State Committee could be strengthened by the appointment of Associate Members, representative of particular branches of Science or Industry. The Associate Members of the State Committees are not members of the Advisory Council.

A State Committee has been established in each State. Considerable delay occurred before some of them were constituted and put in a position to begin work ; but such delay was due to causes beyond the control of the Advisory Council or its Executive Committee. In each case economical arrangements have been made for the use of an office and for an honorary secretary or the part-time services of a paid secretary ; and in most cases the Advisory Council is indebted in these matters to the favour of the State Governments.

It is to be noted that these so-called State Committees are really local Committees of the Federal organization, their members and associate members being appointed by the Commonwealth Government. They must be clearly distinguished from certain " New Industries " and " Research " Committees, which have originated as separate organizations in some of the States.

The chief functions of the State Committees are to collect locally such information as may be required by the Executive and to forward to the Executive such recommendations as local knowledge or local inquiries may suggest. They have no independent executive or financial powers, but they are an extremely important part of the business machinery. The Executive Committee already has had ample proof of this, and is convinced that, in the absence of some such organizations, no central body located in Melbourne could maintain proper relations with the representatives of Science and Industry in other parts of Australia.

The State Committees, as at present constituted, are as follow :—

MEMBERS AND ASSOCIATE MEMBERS OF STATE COMMITTEES, 30TH JUNE, 1917.

New South Wales.

J. T. Elliott, D.Sc.

Professor C. E. Fawsitt, D.Sc., Ph.D.

F. B. Guthrie, F.I.C., F.C.S.

F. Leverrier, K.C. (Chairman).

A. B. Piddington, K.C.

Professor R. D. Watt, M.A., B.Sc.
(Hon. Sec.)

Minister for Agriculture (*ex officio*),

Hon. W. C. Grahame, M.L.A.

J. B. Trivett, F.R.A.S., F.S.S. (Assoc.
Member).

Victoria.

W. T. Appleton.
 D. Clark, M.M.E., B.C.E.
 G. D. Delprat.
 W. Russell Grimwade, B.Sc.
 J. M. Higgins.
 Professor T. H. Laby, M.A.
 Professor T. R. Lyle (Chairman),
 M.A., Sc.D., F.R.S.

Professor D. Orme Masson, M.A., D.Sc.,
 F.R.S.
 Hon. G. Swinburne.
 W. P. Wilkinson, F.I.C.
 Minister for Agriculture (*ex officio*),
 Hon. F. W. Hagelthorn, M.L.C.
 A. M. Laughton, F.I.A. (Assoc. Member).
 A. E. V. Richardson, B.Sc., M.A. (Assoc.
 Member).

Queensland.

G. Bunning.
 Major Alex. J. Gibson, A.M.I.C.E.
 (Chairman).
 J. B. Henderson, F.I.C. (Acting Chairman).
 Minister for Agriculture (*ex officio*),
 Hon. W. Lennon, M.L.A.

N. Bell, A.M.I.C.E. (Assoc. Member).
 W. R. Crampton (Assoc. Member).
 A. J. Gibson, D.Sc. (Assoc. Member).
 J. Gibson (Assoc. Member).
 H. C. Richards, D.Sc. (Assoc. Member,
 Hon. Sec.)

South Australia.

G. Brookman.
 W. W. Forwood.
 W. A. Hargreaves, M.A., D.Sc., B.C.E.

Professor E. Rennie, M.A., D.Sc. (Chair-
 man).
 Minister for Agriculture (*ex officio*),
 Hon. Sir C. Goode, M.H.A.

Western Australia.

E. A. Mann, F.I.C.
 Professor J. W. Paterson, B.Sc., Ph.D.
 (Chairman).
 J. W. Sutherland.
 Minister for Agriculture (*ex officio*),
 Hon. H. B. Lefroy, M.L.A., C.M.G.
 M. Fraser (Assoc. Member).

C. E. Lane-Poole (Assoc. Member).
 A. Gibb-Maitland, F.G.S. (Assoc.
 Member).
 A. Montgomery, M.A., F.G.S. (Assoc.
 Member).
 G. L. Sutton (Assoc. Member).

Tasmania.

Captain J. H. Butters (Chairman).
 J. L. Glasson, M.A., D.Sc.
 H. W. Gepp.
 Minister for Agriculture (*ex officio*),
 Hon. J. B. Hayes, M.H.A.
 H. J. Colbourn (Assoc. Member).

Professor J. H. Mackay, M.C.E. (Assoc.
 Member).
 H. M. Nicholls (Assoc. Member).
 L. Rodway, C.M.G. (Assoc. Member).
 C. H. Slaytor (Assoc. Member).
 W. H. Twelvetees, F.G.S. (Assoc.
 Member).

PART II.—THE POLICY AND NATURE OF THE WORK OF THE EXECUTIVE COMMITTEE.

The nature of the chief work carried out by the Executive Committee and the general policy which has guided it may be summarized under the heads specified below.

1. Collection of Information for Use of Committees and of Permanent Institute.—Information has been collected regarding Australian industries and their distribution, problems connected with them, the equipment and *personnel* of laboratories available for industrial scientific research in all its branches, research work in actual progress in laboratories and experimental work in progress at Government experimental farms, and the facilities available for the proper training of future scientific investigators. The results of these inquiries have been analyzed and summarized in tabular form so far as practicable. Information regarding each of these inquiries, which will form the basis for future activities of the proposed permanent Institute, is given in greater detail hereinafter.

2. Establishment of Relations with other Authorities.—These include State Governments, Scientific and Technical Departments, Universities, Technical Colleges, Scientific Societies, and Associations and Committees representing the pastoral,

agricultural, manufacturing, and other industries. The policy of the Executive in this matter is in accordance with the Report of the original Committee of Conference, which defined the functions of the Commonwealth Institute and included the following among them :—

- “(ix) To keep in close touch with, and seek the aid of, all Commonwealth and State Government Departments, learned and professional societies, and private enterprises concerned with, or interested in, scientific industrial research.”

Much still remains to be done in this direction, but much has been done already by the following means :—(a) Through the agency of the various State Committees ; (b) by correspondence ; (c) by personal interviews between the Executive and various representatives of Government Departments, Universities, and industrial organizations, who have by invitation attended meetings in Melbourne ; (d) by visits which the Executive has paid to Sydney and Brisbane. During these visits the Committee met members of the State Governments, as well as many others interested in the Science and Industry movement, and was able to explain its policy and to elicit cordial approval and promises of active support. These visits were so helpful in every way that the Committee is convinced that similar visits should be paid periodically to the chief centres in turn.

3. Encouragement and Co-ordination of Researches already in Progress.—

One of the functions of the Institute specified in the Report of the Committee of Conference is—

- “(ix) The co-ordination and direction of scientific investigation and of research and experimental work, with a view to the prevention of undesirable overlapping of effort.”

In this connexion the following quotation from the speech of the Acting Prime Minister (Senator Pearce) at the first meeting of the Advisory Council may also be given :—

“ Each of the States pursued to some extent research and inquiries into various questions, and the data they have collected will be available for us ; and of the things towards which you will naturally first turn your attention, one of the most important is to ascertain what data are available, so that there shall be no overlapping. . . . Then, again, there are certain bodies in the Commonwealth that have facilities for investigation and scientific research, and we assume that you will take full advantage of the resources of these bodies and utilize them as much as you can in pursuance of your investigations.”

Much of the work of the Executive has been of the kind thus indicated. Among the many problems in industrial science which have come under the notice of the Executive Committee, probably none are more important to the future of Australia than the problems of increasing the yield of wheat per acre and extending the zone of wheat cultivation into areas now considered too dry. Intimately associated with the latter is the problem of the cultivation of fodder plants in arid regions, with a view to the extension of mixed farming. These problems have received, and are receiving, much attention in different States from specialists in the employ of the Departments of Agriculture. Considerable sums are spent annually on the investigations, and much excellent work is being done. There is, however, a lack of co-ordination and a considerable danger of undesirable overlapping. The Executive has been assured that this is the case by some of the leading wheat experts and other agricultural authorities of Victoria, New South Wales, and Western Australia, who welcomed the proposal of the Executive to call a conference in Melbourne for the discussion of wheat selection and breeding, the cultivation of drought-resisting fodder plants, and allied questions. Ministers of Agriculture, who are *ex officio* members of the Advisory Council, have also expressed approval of the plan. The Executive Committee attach great importance to the proposed conference, but the necessary sanction of the Commonwealth Government for the payment of the expenses of the visitors has not yet been granted.

4. Initiation of New Researches.—The Executive Committee's plan of action in each such case has been to gather and study all available evidence in the form of existing reports, &c., to take verbal evidence, where possible, from men known to be authorities on the special question, and then to appoint a small Special Committee of experts either to give further advice and information to the Executive with a view to

future research or to carry out actual experimental investigations. In the latter case, the Executive has selected the locality and the institution in which the research shall be conducted, and has appointed a salaried investigator to assist the Special Committee, and has voted a reasonable sum for expenses. In this way the Executive believes that it is adopting the best means to give effect to the wishes of the Government and the policy of the Committee of Conference, as expressed in its Report to the Prime Minister. Not only does the course adopted offer a good prospect of the solution, within a reasonable time and at a comparatively small cost, of problems which are important in connexion with existing industries or which may lead to the establishment of new ones, but it affords the best possible means of securing the sympathies of the leading scientists and industrialists and of the scientific institutions in all parts of Australia, these being gradually enlisted in the work of the Commonwealth Institute. Further, the appointment of young scientists as salaried investigators cannot fail to stimulate the training of such men and to increase the supply; and it is obvious that the future success of the attempt to wed science to industry in Australia must ultimately depend largely upon that supply.

PART III.—COLLECTION OF INFORMATION FOR USE OF EXECUTIVE AND STATE COMMITTEES AND OF PERMANENT INSTITUTE.

1. The Problem Census.—One of the purposes for which the Advisory Council was appointed was to invite certain classes of institutions and organizations, as well as private enterprises, “to suggest branches of industrial scientific research in which investigation would be of immediate practical use to producers and manufacturers.” (See Report of Drafting Committee, paragraph 7 (ii).)

It was considered that the respective State Committees, having special local knowledge, would be in a better position than the Executive Committee to secure the information desired in regard to the above matter. A circular letter was accordingly issued to the State Committees asking for information regarding technical and manufacturing problems to be collected under the following heads, viz. :—

- (a) General difficulties or disabilities which affect the development and progress of any existing industry as a whole.
- (b) Any such difficulties which may have been encountered by particular firms engaged in a given industry.
- (c) A return showing opportunities which exist for the establishment of hitherto undeveloped industries, either primary or secondary.
- (d) A statement of national problems deserving the attention of the Committee.

A certain amount of valuable information, which has since been collated, was received in response to these inquiries. Owing, however, to the delay in the appointment of some of the State Committees, the information is not yet quite complete. The matter is further referred to in the reports on the work of the State Committees given in Part VI. of this Report.

2. The Industrial Census.—In conjunction with the above inquiry into technical and manufacturing problems, the State Committees were asked to furnish information as to the distribution, extent, and relative importance of both primary and secondary industries. The ordinary returns published by the Commonwealth and State Statisticians include many industries of such a nature that they are not likely to require immediate assistance from the Advisory Council, and it was felt that the special knowledge of the State Committees would be of value in expunging from the complete lists those branches of industry which need not be considered.

The particular headings under which it was desired that the information should be set forth were as follow, viz. :—

- (a) Nature of industry.
- (b) Distribution (localities).
- (c) Names and addresses of principal firms in each industry included in the return.
- (d) Capital invested.
- (e) Amount of wages paid.
- (f) Number of employees, male and female.

A large amount of information, partly of a confidential nature, has been received by the Executive as a result of these inquiries. It is believed that the detailed particulars furnished in response to the inquiries relating to the problem and the industrial censuses will be of considerable value, and that they, together with the other information collected by the Executive Committee, will largely clear the way for the work of the permanent Institute.

3. Laboratories for Scientific Research and their Personnel.—It has already been pointed out (*see* Part II., paragraph 2, above) that it is the policy of the Executive Committee to seek the co-operation of existing Australian institutions equipped for scientific research, and to utilize, as far as is consistent with economy and efficiency, the services of the skilled investigators attached to such institutions. In order to aid the Executive Committee in its work of initiating and co-ordinating scientific investigations into problems connected with Australian industries, and in order to pave the way in this direction for the work of the permanent Institute, the Executive has collected from Universities, Higher Technical Schools, and Technical and Scientific Government Departments throughout the Commonwealth, particulars of the branches of science for which research laboratories are provided, and of the *personnel* of the staffs.

The results of this inquiry have been collated and analyzed, and are of considerable value in the work of the Executive Committee. They are being kept up to date and will be available for the information and guidance of the Directors of the permanent Institute.

Research work is not, of course, carried on with any regularity in all the laboratories, for which the particulars referred to above have been collected. Many Government laboratories are devoted largely to work of a routine nature, while the staffs of University and Technical School laboratories are ordinarily occupied too much with instruction and "pure" scientific research to devote any considerable part of their time to industrial work. It should also be mentioned that existing laboratories are not ordinarily equipped with apparatus for conducting the "large scale" experiments which are often necessary as an intermediate step between the solution of a problem in the laboratory and the profitable application of the laboratory results on a commercial basis. Further, the Executive Committee has ascertained that the accommodation available in, and the staff and equipment of, existing laboratories in Australia are insufficient for the carrying out of the fundamental work which must be done before many pressing problems can be solved.

4. The Training and Supply of Future Scientific Investigators.—Among the functions of the proposed Institute of Science and Industry, as specified in the Report of the original Drafting Committee of the Conference convened by the Prime Minister, the following is included, viz. :—

- "(xi) To advise the several authorities as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research."

In the opinion of the Executive Committee, one of the most important functions of the Institute will be to encourage higher scientific training, and thus increase the output of skilled specialists available for the development of the primary and secondary industries of Australia. It is hoped to achieve this result by both direct and indirect means; directly, by the employment of salaried investigators to assist in specific researches, as well as by financial grants to institutions for improved equipment; indirectly, by proving to the public the value of industrial scientific research, thus increasing the demand for trained specialists and improving their status and the emoluments open to them.

In order to obtain data for an estimate of the prospects in Australia of a regular supply of trained scientific investigators available for research work, the Executive Committee obtained from the Universities and Higher Technical Schools information relating to the following matters, viz. :—

- (a) Degrees or diplomas granted in Pure or Applied Science.
- (b) The approximate number of such graduates or diplomates annually.
- (c) The approximate annual number of post-graduate research students in Pure or Applied Science.

- (d) The inducements offered to such post-graduate research students by Research Scholarships or otherwise.
- (e) The more pressing requirements for the further encouragement of the higher scientific training, *e.g.*, (1) increase of teaching staff ; (2) additional laboratories ; (3) apparatus and equipment ; (4) undergraduate bursaries ; (5) post-graduate resident or travelling scholarships ; (6) fuller acceptance of degrees or diplomas by outside examining or appointing bodies, such as Government Departments or outside corporate institutions.

The information collected by the Executive in regard to the above matters has been summarized. The results show that the annual number of students graduating in Australian Universities in the pure and applied sciences is only about 110. Of that number a very large proportion are absorbed by the professions, and only a very few receive any proper training in research. The returns received from the Universities and Technical Schools show that the immediately pressing requirements for the proper encouragement of higher scientific training are extensive in regard both to increased teaching staff and additional laboratories, apparatus, and equipment. The output of Australian Universities is insufficient to meet even present demands for research workers. In some branches of science, *e.g.*, Chemistry, the existing shortage is almost entirely due to the fact that a large number of chemists have gone to Great Britain on war work, but this is not the case in other branches of science, especially perhaps in economic biology. The Executive Committee considers that it is a matter of paramount importance that steps should be taken to insure a supply of scientific investigators at least adequate to enable effect to be given to the scheme for industrial scientific research outlined by the Prime Minister in January, 1916. No doubt the demand for research workers will to some extent create a supply, and the Executive Committee has already been able to do something in this direction by the appointment of salaried investigators, while the permanent Institute, when established, will be able to do a good deal more in the same direction. But it is also true that a supply will create a demand.

It is probable that the next few years will see an increasing demand for research workers in Australia, and the responsibility for supplying this demand, and, consequently, the responsibility for the scientific development of the resources and industries of the Commonwealth, must rest largely with authorities other than the Advisory Council or the permanent Institute.

In the Report of the British Committee for Scientific and Industrial Research for the year 1915-16 (p. 40), it is pointed out that one of the primary conditions essential to the success of the movement for the application of science to industry is a largely increased supply of competent researchers. The Executive Committee entirely concurs in that view as far as Australia is concerned.

5. Technical Education and the Training of Artisans.—In addition to the subject of the supply of scientific investigators, the Executive Committee has given attention to the question of technical education and the training of artisans. A large amount of information has been collected from Reports issued by the several Departments of Education and by Royal Commissions, and through personal interviews with experts on the subject.

Underlying the whole question of the scientific development of Australian industries is the training of artisans, and the Executive Committee considers that any efforts made for the application of science to industry will be, to some extent, frustrated unless there is an adequate number of scientifically trained workers. The movement for the application of science to industry is a measure arising out of the war, and it is of urgency that steps should now be taken to meet the conditions that will prevail when peace is declared.

The Committee is of the opinion that the first step towards the improvement of technical education and the training of artisans is an Inter-State Conference of experts, and, having ascertained that the proposal to hold such a conference met with the personal approval of the Directors of Education in all the States, the Committee recommended the Commonwealth Government to take the lead in bringing together the experts in the several States. It is proposed that the *personnel* of the Conference should comprise the Director of Education in each State and an expert in technical education to be selected by each State Government, together with, probably, one or

more representatives of the industrial and business world to be appointed by the Commonwealth Government. The Government has informed the Committee that it does not think it desirable that the action suggested should be taken at present.

6. Register of Research Work in Progress in Laboratories. The Executive Committee has obtained from Universities, Higher Technical Schools, and departmental scientific and technical laboratories throughout the Commonwealth particulars of experimental research work in progress. The particulars comprise in each case the names of the principal investigators, the subject and object of the research, the date of its commencement, co-operation (if any) with outside bodies (*e.g.*, scientific societies, manufacturers' or trade associations), observations as to any impediments to the work (*e.g.*, the investigator too much occupied with instructional work or other duties, lack of funds, of equipment, or of assistance), and if the research has been suspended, the reasons for its discontinuance.

The information thus obtained has been summarized in tabular form. The results show that in a great number of cases the work has either been suspended or seriously impeded owing to pressure of instructional, routine, and other duties.

The register will be of considerable value in enabling expert assistance or advice to be obtained by the Executive Committee or by the permanent Institute when inquiries have to be made in connexion with any of the problems concerned. Moreover, a survey of the directions in which research work is proceeding is likely to lead to the interchange of helpful suggestions and information from time to time between individual workers, while it will assist in obviating unnecessary duplication of effort and in pointing to the directions in which further researches are, or may become, necessary.

7. Register of Experimental Work in Progress at Government Experimental Farms.—The Executive Committee has asked the Government authorities in each State and in the Northern Territory to furnish information regarding experimental work in progress at Experimental Farms, so as to enable them to compile a register of such work on similar lines to those on which the register of research work in progress in laboratories has been compiled. The information asked for has not yet been received from several of the States and from the Northern Territory.

The experience of the Executive Committee leads them to believe that a large amount of the work of the permanent Institute will be in connexion with the agricultural and pastoral industries, and especially with the more fundamental work relating to such matters as plant genetics, plant pathology, mycology, soil fertility, bio-chemistry, animal husbandry and pathology, economic entomology, and agricultural economics. It is believed, therefore, that this register of experimental work at Government farms will be of great assistance and value in the formulation and initiation of the work of the future Institute and in the co-ordination and development of experimental work in connexion with the agricultural industry.

8. Miscellaneous Matters.—With a view to facilitating the initiation of the work of the permanent Institute, the Executive Committee has also collected and classified information both from abroad and in Australia relating to various other matters, such, for example, as—(a) the procedure adopted in regard to new discoveries and processes made or invented by scientific and technical employees of Government Departments; (b) the possibilities of training, and the prospects for the encouragement and advancement of scientific and technical officers in Government Departments; (c) a classified list of chemical manufactures in the Commonwealth; (d) the organization and work of research institutions in other parts of the world.

In connexion with the last matter the Executive Committee has either established relations of a co-operative nature, or is in close touch with various institutions and authorities in other countries, such as—the Department of Scientific and Industrial Research, London; the Royal Society, London; the Imperial Motor Transport Council, London; various scientific Government Departments and other institutions in the United States of America; the Advisory Council for Scientific and Industrial Research, Canada; the Royal Society of Canada; and the Industrial Efficiency Board, New Zealand.

The Committee has also taken action in regard to various other matters of importance in connexion with the application of science to industry, such, for example, as—(a) the admission under the Tariff Acts of scientific apparatus for research or educational purposes; and (b) the admission (with suitable precautions) into Australia of scientific and technical literature published in enemy countries.

PART IV.—INVESTIGATIONAL WORK.

A.—SPECIAL COMMITTEES.

1. Procedure followed.—As explained in Part II., paragraph 4, above, these Committees are appointed by the Executive to report on special problems. They consist in each case of the best experts available, both on the scientific and industrial side, whether members of the Advisory Council or not. In this way the Executive is able to obtain the advice and assistance on any particular problem of the leading minds throughout the Commonwealth. Particular attention has been paid by the Executive to securing adequate representation on these Committees of manufacturers and other persons engaged in industry, both primary and secondary, and much benefit has been derived from this combination of the scientific and industrial points of view.

The Special Committees may be divided into two classes, viz.:—(a) those appointed to carry out actual experimental work; and (b) those appointed to review existing information and to report as to the best lines of future investigation. In the former class are, for instance, the Special Committees on the extraction of potash and alumina from alunite, the production of ferro-alloys suitable for the manufacture of high-speed tool steels, the tanning properties of Queensland mangroves and of redgum in Western Australia, the electrical sterilization of milk, the means of transmission of the worm-nodule parasite in cattle, and the chemical constitution of posidonia fibre. In the latter class are, for instance, the two Committees which met to report upon the important problems of the tick-pest and the worm-nodule parasite, and the Committees on marine biological economics of tropical Australia and the damage done by insects to grain in store.

There are, of course, no hard and fast lines of distinction between these two classes of Committees. In some cases a Special Committee, *e.g.*, the Committee on Chemicals, may be appointed to carry on both classes of work, while in others, a Committee in class (b) having made its report may then proceed to carry out experimental work under a grant made by the Executive. The Special Committees report directly to the Executive, to whom they are responsible. Progress reports are received, ordinarily every two or three months.

The members of the Special Committees act in a purely honorary capacity. Only out-of-pocket and travelling expenses are paid, and then only in the case of members attending from a distance the meetings of their respective Committees. The Executive Committee desire to express their cordial thanks to the members of the Special Committees for the valuable services they have rendered. Without their assistance it would have been impracticable for the Executive to have carried on their investigational work efficiently.

2. Special Committees Appointed.—Particulars of the Special Committees appointed up to the 30th June, 1917, are given in the following tabular Statement. The total number of Committees appointed is 20. The total amount of the grants is £3,435, but no grant has been made to four of the Committees (Marine Biological Economics of Tropical Australia, Damage by Insects to Grain in Store, Control of Sparrow Pest, and Classification of Imports of Chemicals).

PARTICULARS OF SPECIAL COMMITTEES APPOINTED BY THE EXECUTIVE COMMITTEE UP TO THE 30TH JUNE, 1917.

Subject.	Date of Appointment.	Personnel.	Grants.
1. Chemicals	30th May, 1916	Prof. Masson (Chairman), and Messrs. V. G. Anderson and E. A. Mann, and Dr. F. H. Campbell	£10 for apparatus in connexion with cream of tartar investigations
2. Ferro-Alloys	15th June, 1916	Messrs. A. J. Higgin (Chairman) and W. N. Kernot	£150 for working expenses, and £30 a month for three months for employment of assistant
3. Standardization of Designs for Scientific Apparatus	11th July, 1916	Profs. Laby (Chairman), A. J. Gibson, Kerr-Grant, and Wilsmore, and Messrs. D. Clark, W. A. Holmes, W. N. Kernot, and F. Nangle	For salary of draftsman for one year, at rate in Commonwealth Public Service (£275)
4. Mode of Occurrence of Gold in Quartz	15th July, 1916	Prof. Skeats (Chairman), and Messrs. E. C. Dyason, H. Herman, and Dr. F. L. Stillwell	£100 for one year for employment of investigator
5. Tick Pest	21st July, 1916	Major J. D. Stewart (Chairman), Drs. S. Dodd, T. Harvey Johnston, and J. A. Gilruth, and Messrs. G. E. Bunning, A. H. Cory, D. J. Kerr, J. Kidd, C. J. Pound, W. A. N. Robertson, and S. T. D. Symons	£100 for travelling and out-of-pocket expenses, in addition to cost of reporting and typing

PARTICULARS OF SPECIAL COMMITTEES APPOINTED BY THE EXECUTIVE COMMITTEE—*continued.*

Subject.	Date of Appointment.	Personnel.	Grants.
6. Alunite	1st August, 1916	Mr. A. J. Higgin (Chairman), Prof. Masson, and Mr. V. G. Anderson	£100 for working expenses. £30 per month for twelve months for employment of assistant
7. Yeasts and Bread-making	2nd August, 1916	Dr. H. G. Chapman (Chairman) and Mr. J. Nangle	£200 for equipment and working expenses
8. Nodule Disease in Cattle	2nd August, 1916	Drs. S. Dodd (Chairman), A. Breial, J. B. Cleland, J. A. Gilruth, T. H. Johnston, S. J. Johnston, D. J. Kerr, W. Nicoll, and G. Sweet, and Messrs. G. E. Bunning and T. A. Field	£100 for travelling and out-of-pocket expenses, in addition to cost of reporting and typing
9. Marine Biological Economics of Tropical Australia	1st November, 1916	Messrs. C. Hedley (Chairman), E. J. Bantfield, and A. R. McCulloch, Prof. Dakin and Dr. R. H. Harris	Nil
10. Damage by Insects to Grain in Store	14th December, 1916	Messrs. L. Rossell (Chairman) and W. W. Froggatt and Prof. Haswell	Nil
11. Electrical Sterilization of Milk	21st December, 1916	Dr. J. B. Cleland (Chairman) and Mr. W. H. Myers	£100 for apparatus and working expenses
12. Tanning Properties of Queensland Mangroves	13th February, 1917	Messrs. J. Gibson (Chairman), L. S. Bayster, and J. B. Henderson	£200 for apparatus and working expenses
13. Tanning Properties of Red-gum in Western Australia	20th February, 1917	Messrs. B. Rosenstamm (Chairman), I. H. Boas, C. E. Lane-Poole, and C. E. Stacey	£300 for employment of assistant and working expenses (not yet approved)*
14. Means of Transmission of Worm-Nodule Parasite	27th February, 1917	Drs. S. J. Johnston (Chairman) and J. B. Cleland	£150 for travelling and out-of-pocket expenses and payment of assistant
15. Control of Sparrow Pest..	1st March, 1917	Captain S. A. White	Nil
16. Alcohol Fuel and Engines	8th March, 1917	Prof. Lyle (Chairman) and Messrs. W. R. Grimwade, W. N. Kernot, and H. V. McKay	£250 for working expenses up to the 30th June, 1917
17. Classification of Imports of Chemicals	19th April, 1917	Mr. W. R. Grimwade (Chairman), Dr. F. H. Campbell, and Mr. E. T. McPhee	Nil
18. Tanning Methods of New South Wales	24th April, 1917	Prof. Fawsitt (Chairman), and Messrs. B. Bailey, F. A. Coombs, F. B. Guthrie, and H. G. Smith	£450 for equipment, working expenses, and employment of assistant
19. Posidonia Fibre	22nd May, 1917	Prof. J. Read and Mr. H. G. Smith ..	£150 for working expenses and employment of assistant (not yet approved)
20. Grass-tree	19th June, 1917	Prof. Rennie (Chairman), Dr. Cook, and Messrs. Finlayson and Hurst	£50 for purchase of chemicals (not yet approved)

* Recommendation for grant of £25 already approved.

Of the total sum mentioned, the proposed grants to the Special Committees on the tanning properties of redgum in Western Australia (£300), on the chemical constitution of posidonia fibre (£150), and on grass-tree (£50), had not been approved at the end of June, 1917.

The Executive Committee has under consideration the appointment of other Special Committees at an early date to deal with important problems to which it has already given attention.

3. General Progress of Work of Special Committees.—As will appear from the more detailed information furnished hereinafter regarding the various investigations initiated and undertaken by the Executive Committee, considerable progress has been made in the work of many of the above Special Committees, some of which are approaching the completion of their investigations.

As regards the Committees on the tick-pest and the nodule disease in cattle, full reports have been received by the Executive based on the information available as the result of the various investigations already carried out by other authorities. Lines of further action for attacking the problems and for the control and eradication of the pests have also been formulated by these Committees. The Executive has concluded that the questions involved in the control and eradication of these pests are too large and complex to enable them to be dealt with efficiently under the existing temporary organization with its limited financial resources and executive powers. Moreover, any action with a view to the control of these pests can be carried out by the Federal Government only with the co-operation of State authorities, so that the relations between the proposed permanent Institute and these authorities must be determined before any comprehensive lines for action can be adopted. So far as practicable the Executive Committee has, however, arranged for further necessary

investigational work to be carried out in connexion with these problems. Thus the Special Committee on the means of transmission of the worm-nodule parasite is conducting fundamental investigations into matters that must be cleared up before a complete scheme for control can be brought into force.

It will be found in a later part of this Report that the above remarks apply equally to certain large problems to which the Executive Committee have given full consideration, but for which they have not thought it desirable to appoint Special Committees. For example, the whole question of the utilization of forest products involves issues that are too large and complex to enable the existing temporary organization to deal with it in the comprehensive manner which its importance and magnitude demand. Though it would probably have been practicable for the Executive Committee to tackle one or more of these large problems on a limited scale in particular States, the Committee holds the view that they are essentially problems that should be viewed from a Federal standpoint and dealt with, as far as practicable, on Inter-State lines of action.

B.—AGRICULTURAL AND PASTORAL INDUSTRIES.

1. The Control and Eradication of Pests and Diseases of Stock and of Crops.—The loss caused, directly and indirectly, to the agricultural and pastoral industries of Australia, and the secondary industries dependent on them, by the attacks of pests, parasites, and organisms causing disease amounts to millions of pounds per annum. Nearly all the most serious pests in Australia have been introduced from other countries, and it is therefore probable that the introduction of many of them could have been prevented by rigid measures of quarantine. Such pests as were introduced in spite of the quarantine could probably have been easily exterminated if they had been attacked in a scientific manner as soon as their presence and injurious nature were notified in any locality. Now that many of them have become diffused over the whole or a great part of Australia, the work of eradication would be costly and take a number of years, but there is little doubt that properly organized campaigns conducted with the active assistance of the industries concerned would ultimately be successful.

Before an efficient campaign against any of these pests can be organized, it is necessary that the life-histories of the pests and the methods by which the parasites are transmitted from one host to another should be fully understood, and the Committee considers that investigations of this kind should form an important part of the functions of the proposed permanent Institute. In the past and at the present time much valuable work of this nature has been and is being performed by Government entomologists and other State officers, as well as by the members of the staffs of Universities and Agricultural Colleges, but most of these researchers can only give part of their time to such work. Moreover, there is a considerable amount of overlapping and repetition which should be avoided when the central Institute comes into existence.

Whilst investigating the life-histories of the pests the Institute's biologists would also carry on such further experiments as may be necessary into the best methods for their eradication. In the light of their experience it would then be possible to formulate proposals for an organized campaign against them, and it is obvious that such a campaign would have a better chance of success if planned by a central organization. At present, when one State organizes such a campaign, it is not always easy to arouse the enthusiasm of the community, without whose assistance any such campaign must be a failure, for there is always a probability that, in spite of any measures taken within one particular State, the pest may be re-introduced from a neighbouring State. The first step in such a campaign is obviously to prevent the spread of the pest. When once this has been accomplished it becomes possible to work backwards towards the centre of the affected area. In this connexion the Committee is taking action with a view to preventing the spread of sparrows into Western Australia. (See paragraph (iv) below.)

Of the pests and diseases injurious to stock in Australia the principal are the cattle-tick, the worm (*Onchocerca gibsoni*) which produces nodules in beef, the sheep blow-fly, and the tubercle bacillus. As a result of their preliminary inquiries, the Committee learnt that the cattle-tick and the nodule-worm had engaged the attention of numerous workers, and that various papers on different aspects of the subject had been published. It was therefore decided to appoint Special Committees to review the results of past scientific work, to suggest what further work should be undertaken, and

to make recommendations as to the best means for the control and eradication of the parasites. These Committees met at Sydney in September, 1916, and it is hoped shortly to publish their reports. (See paragraphs (i) and (ii) below.) After considering their recommendations the Executive Committee decided that the suggested campaign for the eradication of cattle-ticks was too large a matter to be undertaken by the present temporary body. In the case of the nodule-worm the means of transmission of the parasite from one host to another are still unknown, and the Committee have given a grant to Drs. J. B. Cleland and S. J. Johnston, who are engaged in an investigation of this problem.

The subject of tuberculosis in stock was investigated by a sub-committee of the Queensland State Committee, and its report has been published by the Queensland Government. (See paragraph (iii) below.)

The sheep blow-fly pest is being investigated by a joint committee of the New South Wales Government and the Pastoralists Association, which began work in 1914. The members of the Executive met this Committee when they visited Sydney, in August, 1916, and assured it of their cordial support. They have since kept in touch with the work of the Pastoralists Committee.

The ravages caused by various insect pests have been brought before the Committee on different occasions, and a considerable amount of information on this subject has been collected. In September, 1916, the Committee received a request from the Royal Society, through the Commonwealth Government, asking them to co-operate in an investigation which that society was undertaking at the request of the Imperial Government as to the damage caused by insects to stored grain throughout the Empire. The Committee, after obtaining reports on the subject from the Government Entomologists of the various States, decided to appoint a Special Committee in Sydney to investigate the matter, which is evidently of great importance at present in view of the fact that for the first time in Australian experience large quantities of grain are being stored in the Commonwealth owing to the shortage of shipping. An interim report prepared by this Committee has been circulated to the Ministers for Agriculture, Chairmen of Wheat Boards, and Government Entomologists of all the States. (See paragraph (v) below.)

It is probable that the unprecedented amount of grain stored in Australia was responsible also for the serious plague of mice which occurred in New South Wales, Victoria, and South Australia in the early months of 1917. The Executive is in communication with Professor Splendore, of Rome, regarding a bacillus discovered by him, which is stated to have proved successful in coping with a plague of rodents in Italy.

The following sub-sections in small type give more detailed information regarding matters referred to above. The same course is followed in succeeding parts of this Report.

(i) *Tick Pest*.—The cattle tick (*Boophilus australis*) was probably introduced into Australia from Java with cattle imported in 1872, and is now distributed throughout the coastal areas of Northern Australia from Western Australia through the Northern Territory and Queensland to northern New South Wales. In addition to the direct damage done by the tick itself, it is the means of spreading the organism which causes "tick" or "Texas" fever. The Special Committee state in their report that the loss from mortality caused by tick fever in Queensland alone is estimated at seven million pounds sterling. Cattle which survive the fever suffer from loss of condition and diminution of milk yield, but this loss cannot be estimated. Apart from the fever, the presence of ticks on the cattle causes serious loss of condition and a considerable mortality from "tick worry" and "tick poverty," also a diminution in milk yield and an interference with the natural increase of the herds. Hides from tick-infested animals are of much less value for leather, the loss from this cause in Queensland alone amounting to about £114,000 per annum. If the collective losses over the series of years since the advent of the pest, from the varied causes directly attributable to it, could be enumerated, they would amount to many millions of pounds.

Apart from the direct losses referred to, the expenditure occasioned in connexion with the erection and maintenance of dipping vats, and general disturbance of stock business, is also very considerable. As the effects of loss to the stock industry ramify through commerce in an extensive manner, the secondary industries also pay their toll to the pest. Further, the restrictive measures various States have been compelled to put into operation have led to considerable expenditure. For instance, the cost to New South Wales alone has amounted to £123,480 during the past five years.

Loss is also occasioned to owners of stock within quarantined areas, by the application of the restrictive measures imposed not only in connexion with treatment enforced, but in the interference and curtailment of their businesses, and deterioration of their herds. Moreover, the value of land in infested and adjoining areas has depreciated even up to 40 per cent. When the extent of acreage involved is considered, this loss alone becomes stupendous.

The life-history of the Australian cattle-tick, which is closely similar to the American cattle-tick (*Boophilus annulatus*), is briefly as follows:

When the female tick becomes fully matured, she drops off the cow on to the ground, and after a few days commences to lay eggs. The number laid varies from about 2,000 to 5,000, the average being about 3,000. The eggs are very resistant to external conditions, being able to withstand severe frosts and heavy rain. After a period, which varies according to conditions, the young "seed-ticks" hatch out and ascend the bushes, fences, &c., collecting in masses ready to swarm upon any object that brushes past. They are very tenacious of life, and it is not improbable that under Australian conditions they may be able to survive for a year awaiting a suitable host, though this has not been determined by research. When a cow comes within reach the seed-tick crawls over its skin till it finds a soft part, and there attaches itself and commences its parasitic life by sucking blood from its host. If infected it may cause fever, although so small as to be difficult to detect with the unaided eye. After two moults it assumes the adult form, and the life-cycle is thus completed. The parasitic existence lasts for about three weeks.

The eradication of the tick is of primary importance, for without the tick there can be no tick-fever. The tick may be attacked either during its existence on the pastures or during its parasitic development on its host. In freeing pastures the plan usually followed is called the "starving-out" method, and consists in excluding all possible hosts of the tick from the pastures until sufficient time has elapsed for the tick to die out and the eggs to perish. Upon removal of the cattle the land in America usually placed under cultivation, and it is not re-stocked until sufficient time has elapsed to assure death of the progeny of the ticks that were dropped there. There exist no reliable data as to the safe limit of this period in Australia, though field observations in the North Coast districts of New South Wales indicate that it exceeds one year. The success of this system depends on a more efficient control of stock than exists in this country, and as a method for general adoption in Australia, it does not commend itself to the Committee, but it may be applicable in isolated cases.

It is considered that the most efficacious method of controlling the pest is to attack the tick during its parasitic existence.

The methods employed are—

- (1) Hand-picking and grooming of small herds of cattle and stabled horses undertaken daily.
- (2) Hand-dressing and spraying of small lots of quiet cattle and horses and of pregnant and injured animals every seventh day.
- (3) Dipping, by causing the animals to plunge into a tick-destroying solution contained in a narrow tank, so as to become completely submerged, and on rising to the surface to swim for a short distance. Experience to date indicates that arsenic is the only reliable tick-destroying agent at our disposal. This process has to be repeated about every fifteenth day for a considerable period.

In the United States systematic effort for the eradication of the tick commenced in 1906. The territory south of "Salmon's line," comprising 741,515 square miles, was placed under quarantine restrictions. According to the latest returns a total of 262,469 square miles have been freed from ticks and released from quarantine.

The State Departments co-operate with the Federal officials of the Bureau of Animal Industry, and before work is commenced the co-operation of stock-owners and local authorities is enlisted by means of an educational campaign in which illustrated pamphlets and literature of various kinds advocating that "it pays to eradicate the tick" are distributed. The annual amount contributed by the States interested is about £100,000, while the Federal Government contributes about £60,000.

The Special Committee recommended—

- (1) As the matter is of national importance, and vital to the prosperity of the Commonwealth, the Federal Government should undertake the work of eradicating the pest. For this purpose a special appropriation would be necessary, but even if it amounted to £50,000 per year, it would but represent a moderate premium for assurance of the safety of the cattle and dairying and allied industries, and would be more than repaid in a brief time by the benefits derived from its judicious expenditure.
- (2) Investigations of the biology of the cattle-tick in Australia.
- (3) Investigations of the life-cycle of the causal organism of tick fever (*Babesia bigemina*) within the cattle-tick.
- (4) Researches on the nature of protective inoculation.
- (5) Curative treatment of tick fever.
- (6) Research as to the cause of the natural resistance to tick of some cattle and as to whether it is hereditary or transmissible.
- (7) Researches as to the best composition of tick-destroying medicaments in different climates and conditions.

(ii) *Worm Nodules in Cattle*.—Cattle in the Northern Territory, Queensland, Western Australia, and parts of New South Wales are parasitized by a species of nematode worm (*Onchocerca gibsoni*), which leads to the formation of fibrous nodules, or worm nests, in certain parts of the body of the animal. The nodules enclose one or more tightly-coiled worms, and vary in size from a split-pea to a walnut or larger. There may be only one or two, but there may be 50 in a single animal, and they are almost always confined to two regions, the brisket and the flanks, being most numerous in the former position. The parasite is not known to occur outside Australia, but as cattle are not indigenous to this country it is almost certain that it must have been introduced from some other country. The presence of the nodules was first observed in 1880.

Up to the present, in spite of many independent investigations by different scientists, the method by which the parasite is transmitted from one beast to another has not been discovered, but from our knowledge of the life-histories of related parasites in other animals, it is almost certain that it must be spread by an intermediary host, probably some biting insect.

In the year 1910 the discovery of nodules in Australian beef by the British authorities led to an agreement under which the Commonwealth guaranteed that portions of carcasses containing nodules would not be shipped to Great Britain.

At that time the British authorities maintained that the nodules exerted a deleterious effect on the beef, though such beef had been consumed for a number of years both in Australia and in Great Britain without any harmful results being observed. Nevertheless, the appearance of the nodules on section is uninviting; while old degenerated nodules not infrequently present an appearance suggestive of a tubercular lesion, hence it is not surprising that their presence should be objected to.

In order to carry out their agreement the Commonwealth Government framed regulations specifying that certain portions of the brisket must be removed from carcasses of beef before exportation to Great Britain, and that the hindquarters should be opened for examination.

These regulations result in serious loss to the exporter, and thus, indirectly, to the Commonwealth—

- (1) By the actual loss of weight resulting from the removal of the brisket from a carcass, and the extra cost of handling entailed by this treatment. (Part of this loss is, however, apparently recovered by separate sale of such briskets locally or to other countries.)
- (2) By the depreciation in value of the carcass due to the mutilation. A carcass that has been mutilated by cutting will not bring so high a price as one that has been untouched.

Two independent estimates made by meat exporters, one in Sydney, the other in Brisbane, place the loss per carcass at 18s. 3d. and 18s. 11d. respectively, without reckoning loss due to the mutilation of the hindquarter. In the three years 1913 to 1915, the number of carcasses exported from Queensland was 1,435,000, which, on the lower estimate, means a loss of £1,310,000 for the three years, or an annual loss of £436,000. It is probably well within the mark to state that the nodule disease results in an annual loss to the Commonwealth of over half a million pounds. The Special Committee, after full consideration, finds no evidence that nodule-infested meat is in any way unfit for human food. It considers that the present regulations result in an unnecessary amount of loss, and that the matter should be discussed by the British and Australian authorities, with a view to arriving at some means whereby the British consumer may be insured against having nodules served at his table, without so much loss being caused. It is important to realize that, while the loss falls on the producer, the consuming public in Great Britain is affected also owing to the diminution of the amount of beef imported into that country from Australia. In view of the recent diminution of the world's live-stock and the increased demand for beef, such a factor is by no means negligible.

The Special Committee also recommends that a zoological survey of various areas should be undertaken, with a view to ascertaining the presence and extent of worm infection, and that research as to the means of transmission of the parasite should be continued.

The Executive has made a grant to Drs. J. B. Cleland and S. J. Johnston to assist them in their researches on the latter problem. Up to the present they have devoted most of their attention to March-flies, which they consider the most probable intermediary host, but the larval nematodes have not yet been found in the alimentary canal of these insects. They have also examined freshwater crustacea from the drinking places of the cattle, as well as cattle-lice, but so far with negative results.

(iii) *Tuberculosis in Stock*.—The Sub-Committee appointed by the Queensland State Committee to consider this matter prepared a Report, which was published by the Queensland Government early in 1917. Basing their estimate on very conservative figures, the Committee came to the conclusion that the annual direct and indirect loss to the State of Queensland due to tuberculosis amounts to nearly £420,000. Quite apart from any loss of wealth, however, is the greater loss due to the infection of members of the community from animal sources. Tuberculosis is a preventible disease, but the problem of human and animal tuberculosis must be considered together, and the Committee recommends that the Commonwealth Government should be urged to establish one central authority to deal with the whole matter.

They also recommend that the Acts and regulations at present in force should be properly applied, so that the consumers may be safeguarded against infection from milk, beef, or pork containing tubercle bacilli. In order that such measures should be efficiently carried out it is essential that the public should be thoroughly informed as to the necessity of the various measures. A further aid towards the co-operation by the public with the authorities will be obtained by establishing compensation for animals ordered to be destroyed, and by the adjustment of equitable conditions in relation to burdens imposed for the public welfare upon the producers or people immediately concerned.

(iv) *Sparrows*.—The attention of the Executive was drawn to the probability that the completion of the Transcontinental Railway was likely to result in the spread of these birds, and possibly also of starlings, to Western Australia, in which State they are not at present found. As a result of inquiries, this probability was strengthened, as it was discovered that sparrows had already travelled some distance westward along the line.

Captain S. A. White, of Adelaide, past president of the Royal Australasian Ornithologists Union, offered his services to the Committee gratuitously to investigate the matter, provided the Federal authorities would give him the necessary facilities for travelling on the railway. This was arranged, and Captain White made his first special trip to the head of the line in May, 1917. He reports that he traced sparrows for 200 miles along the line, and he collected evidence which points to both sparrows and starlings having been seen further west, though it is probable that they came inland from the coastal settlements of Fowler's Bay and not along the railway route. He hopes to make another journey along the line in July or August to see if the sparrows have progressed, and he expects then to be in a position to make definite recommendations as to methods of checking their progress.

(v) *Insects damaging Grain in Store.*—A number of insects have been reported from time to time as damaging stored grain in Australia, but all of them have been introduced from other countries, and most of them have a world-wide range. The most serious pests in every State are the Grain-weevils (*Calandra granaria* and *C. oryzeæ*); in the warmer States the Grain-moth (*Gelechia cerealella*) is regarded as the next most destructive insect, whilst in New South Wales and Victoria the Grain-beetle (*Silvanus surinamensis*) is placed third on the list.

In October, 1916, the Executive Committee received through the Prime Minister's Department a communication from the Royal Society, London, asking that a Committee should be appointed in Australia to inquire, in co-operation with similar committees in England and Canada, into the damage done by insects to grain in store. A Special Committee was duly appointed, and presented a Progress Report in May, 1917, dealing with the Grain-weevils, which they find are the only insects attacking stored grain whose destructive effects are serious enough to demand special measures.

The Report points out that wheat when bagged in the paddock has no weevil in it, but subsequently becomes infested by being placed in old bags, or in granaries, stores, trucks, &c., infested by weevils, or in contact with infested grain. The various methods of destroying weevils by poisonous gases cannot be applied to bagged grain except at prohibitive cost, though applicable to grain stored in bulk. The most effective gas is carbon-dioxide.

Study of the life-history of the weevil shows that it is dependent on certain conditions of temperature and moisture. Weevils do not multiply in wheat unless it contains 10 per cent. of moisture. Wheat from threshers contains from 6·7 per cent. to 7·2 per cent. of moisture, and is therefore weevil-proof unless moisture is actually added from without. At the present time in Australia hardly any stacks are rain-proof; many of them are placed on the ground so that moisture can penetrate them from below, and most of them are in close proximity to the sea, and are thus constantly in a moist atmosphere. It is probable, therefore, that the depredations of weevils are likely to be extremely serious, since, under favorable conditions, in one experiment 40 weevils in three months produced over 3,000 descendants.

2. The Control and Eradication of Weed Pests.—It is impossible to estimate the loss caused to Australia by various introduced plants which have established themselves in this continent, and in some cases occupied large tracts of country. Of the hundreds of weeds which have been recorded from the different States, almost all are aliens. Almost the only native plants which come under this category are the Bracken-fern and the various Poison-plants. The introduction of weed-seeds with imported grain is inevitable, though adequate inspection reduces the danger from this source to a minimum, but many of our worst pests are plants which have escaped from cultivation in gardens, and it is obvious that useful or ornamental plants cannot be excluded from Australia on the ground that they might at some future date become pests.

At the present time, when a new weed is notified in any district the Department of Agriculture of the State gives advice as to the methods by which it is most likely to be eradicated, and it is the business of the individual on whose land the pest has appeared, or of the District Council or other local body, to take means to deal with the weed if they see fit. If the weed appears on Crown land or along the roadsides, it is usually neglected altogether, with the result that a plant which might easily have been stamped out if proper means to control it had been taken at the outset becomes a menace to agriculture over a large district, and the values of all land in the district are depreciated.

An important part of the work of the Institute of Science and Industry would be the study of weed-pests, and the best means of controlling them, and it is obvious that it would be desirable that the directors should be informed by the State Departments when any new weed appeared, in order that a comprehensive study of the best means of eradicating it might be undertaken. This would involve, at any rate in some cases, a study of the plant in its native country in order that the natural enemies which kept it in control in that country might be ascertained. The Institute would then be in a position to report as to the best means of dealing with the pest with a view to its complete eradication.

In considering the problem of the eradication of some of our weed-pests, the Executive have had various suggestions for the utilization of these plants placed before them, but have come to the conclusion that, though this consideration should not be neglected, its chief importance lies in the possibility that the industrial utilization of some products of a plant-pest may serve to lessen the cost of eradication. The proper course of action is to aim primarily at control and eradication, industrial utilization being an important, but a secondary, consideration.

The most serious weed-pest in Australia is the Prickly Pear (*Opuntia inermis*), which occupies some 20 million acres of land in Queensland, and $2\frac{3}{4}$ million acres in New South Wales, and is estimated to be spreading in Queensland at the rate of a million acres a year. The Executive Committee, after informing itself fully of the

research work on methods of eradication carried out in Queensland by the State Government's Board of Advice on Prickly Pear Eradication, drew up a Report on the subject, with recommendations as to further work. This Report was presented to the Commonwealth Government in December, 1916. (See paragraph (i) below.)

Another weed which threatens to become a very serious pest in the temperate parts of Australia is the St. John's Wort (*Hypericum perforatum*). Starting from Bright, in Victoria, the plant has been carried in various directions by stock, and it is estimated that 184,000 acres are now occupied by it in Victoria, whilst it has also appeared in various localities in South Australia and New South Wales. Experiments conducted some years ago on behalf of the Victorian Department of Agriculture indicated that the best method of treatment was to cover the land with salt, but no treatment of this nature is applicable to the hilly country, which forms the stronghold of the plant, and from which it constantly spreads on to the cultivated land in the valleys. The Committee came to the conclusion that a possible solution of the problem would be the introduction of some insect which would feed only on St. John's Wort, and they have written to England to ascertain if any such insects are known in that country, of which St. John's Wort is a native.

The Queensland Department of Agriculture has recently introduced from Hawaii a fly whose larva feeds on the seed of the lantana, and which has been found effective in keeping down this pest in the Hawaiian Islands, Fiji, and New Caledonia. This method of dealing with weeds—the introduction of the insect foes which keep them within bounds in their native countries—is obviously the most scientific, and, provided that proper inquiries and experiments are first made to insure that the insects introduced are not likely to attack useful plants, and become pests in their turn, should be much the most economical method of solving the problem. A notable example of the success of this plan was the introduction from India of a cochineal insect (*Coccus indicus*), which feeds on one species of Prickly Pear (*Opuntia monacantha*). This particular Prickly Pear has been almost exterminated in localities in Queensland where the insect has been liberated, but unfortunately the insect will not attack the pest pear (*O. inermis*), for which other insect foes must be found.

Among other weeds for which remedies remain to be provided are the Water Hyacinth, the African Box-thorn, the Bramble, the Sweet-briar, and the Bracken-fern, as well as such weeds of cultivation as the Stinkwort, Charlock, Thistles, &c. The Committee has collected a good deal of information as to the methods adopted for dealing with some of these plants in other countries, but much research requires to be done to ascertain the best means of tackling each of these pests in Australia, and the permanent Institute should be able to accomplish much valuable work in this direction.

(i) *Prickly Pear*.—The following Report and recommendations on the control and eradication of the Prickly Pear were adopted by the Executive Committee of the Commonwealth Advisory Council of Science and Industry :—

1. The eradication of the Prickly Pear, being one of the problems mentioned in the initial Report on the constitution of the proposed Institute of Science and Industry as specially urgent, has received close attention from the Executive since the commencement of its activities.

2. The Executive Committee has fully informed itself of the research work on this problem already carried out in Queensland by the State Government's Board of Advice on Prickly Pear Destruction. The Executive has also interviewed members of the State Governments of New South Wales and Queensland, and ascertained the attitude of these Governments towards the problem.

3. Some 20 million acres of land in Queensland and 2½ million acres in New South Wales are at present infested with Prickly Pear, and it is estimated that the pest is spreading in Queensland at the rate of one million acres a year. Prickly Pears have also established themselves in various localities in Victoria, South Australia, and Western Australia, but are not at present serious pests in these three States. Eleven species of Prickly Pear have become naturalized in Australia, but *Opuntia inermis* is the species whose spread has been so serious and which occupies the great bulk of the pear-infested land.

4. The only practicable means of dealing with the plague appear to be :—

(1) Chemical (by poisoning).

(2) Biological (by introducing insects or fungi which act as a natural check on its growth).

Various proposals have been made to deal with the Prickly Pear by mechanical means by cutting or rolling it down. These have not, however, been found practicable. Other proposals have been made to dispose of the pear by utilizing it for certain purposes. But even if a profitable means of utilization were discovered, it would be quite impracticable to establish in Australia factories on a sufficiently large scale to deal with any substantial proportion of the pear. The most likely use for Prickly Pear is for fodder, but all the cattle in Australia could not keep pace with the rate at which the pear is extending in Queensland alone. It is necessary first to find some means of controlling and eradicating the pest. Any experiments made with a view to the discovery of some practicable use for the Pear should not be conducted in the belief that they can lead to its control.

5. An elaborate series of investigations on the effect of all known plant poisons on the Prickly Pear was carried out by Dr. Jean White, for the Queensland Government, at Dulacca. These investigations have shown that the cheapest and most efficient means of destroying Prickly Pear are by the injection or spraying of the plants with arsenic acid or by gassing it with the fumes of arsenic trichloride. The quantities of these substances required and the seasons when they can be used to most advantage have also been ascertained. The Dulacca Experiment Station was closed on 30th June, 1916, and the Queensland Government have offered to hand it over to the Commonwealth for the use of the Advisory Council in any further researches it may undertake.

6. Chemical poisoning will only pay on agricultural land, which is but a small proportion of the infested area. The pear on grazing land of low value can only be kept in check by biological means, and meanwhile these lands act as sources from which the land already cleared is in perpetual danger of re-infestation.

7. The first part of the necessary biological investigation was carried out by a Travelling Commission consisting of Dr. T. H. Johnston and Mr. H. Tryon, appointed by the Queensland Government. These gentlemen spent nearly two years visiting almost all the countries of the world where prickly pears are found, either native or acclimatised, and investigating the natural enemies of the plants.

8. The Commission introduced a species of Cochineal Insect which feeds on *Opuntia monacantha*, and after careful tests at Dulacca had shown that it would not attack cereals or fruits of any kind, it was liberated at Bowen and Charters Towers, with the result that *Opuntia monacantha* in those localities has been largely destroyed. Unfortunately, this insect will not feed on any other species of Prickly Pear.

9. The Commission prepared a list of a number of other insects which live entirely on Prickly Pear in America and are not known to feed on any other type of vegetation, and which they recommend should be introduced to Australia with proper safeguards. They also made tentative arrangements with the United States Bureau of Entomology for the collection and despatch of these insects. They further recommend that two fungi which cause diseases of Prickly Pear in South America should be introduced and investigated. These suggestions have not been acted upon up to the present.

10. As the result of an interview which the Committee had with members of the Government of New South Wales, the Minister for Agriculture announced that £2,000 had been placed on the Estimates to be at the disposal of the Advisory Council for research work on the Prickly Pear problem, provided that the money is spent in the State. He also indicated that this sum would be continued for five years. The Committee also interviewed members of the Queensland Government, and it is practically certain that the Government of that State will be willing to contribute the same amount as New South Wales (£2,000).

RECOMMENDATIONS.

The Executive Committee therefore recommends:—

- (a) That investigations should be carried out as to the suitability of insects and fungi known to be inimical to Prickly Pear for acclimatisation in Australia, as to the method of action of such insects or fungi on the pear, and as to such other matters as may arise in connexion with any biological or chemical researches found necessary.
- (b) That the work should be placed under the authority of a biological expert, who shall be responsible to the Executive Committee of the Advisory Council of Science and Industry, and who should receive a salary of £1,200 per annum.
- (c) That three laboratories, comprising one central laboratory and two subsidiary laboratories, should be established and maintained in Queensland and New South Wales.
- (d) That the central laboratory should be established at Brisbane, where the insects would be received immediately they reached Australia, and where the staff would have access to literature and facilities for the use for special investigations of University and Government laboratories.
- (e) That the two subsidiary laboratories should be established in country infected with Prickly Pear. One of these should be in New South Wales, whilst, for the other, the Queensland Government's offer of the Dulacca Experiment Station should be accepted. These stations would carry out the work of breeding and testing the introduced insects, and should be in charge of thoroughly qualified entomologists, at salaries of £750 per annum.
- (f) That field laboratories should be established, at such places and at such times as may be deemed necessary by the biologist in charge, for the purpose of introducing such insects as are found suitable into particular areas, or for other special purposes.
- (g) That the sum of £8,000 per annum for a period of five years should be made available for this work, of which sum £4,000 should be contributed by the Commonwealth Government, and £2,000 each by the Governments of New South Wales and Queensland.

It is regarded as important that provision should be made that such amount as may remain unexpended at the expiration of any one year should not lapse, but should be carried forward to the next year. Owing to the nature of the inquiry, the fact that the insects will have to be bred to some extent in America, and the dependence of the insects on seasonal factors, it seems probable that part of the sum allotted for this purpose in the first year will remain unexpended, and that correspondingly this item will be increased in the second year.

3. The Cultivation of New or Improved Crops.—The Executive Committee has received numerous suggestions as to the desirability of cultivating in Australia crops which produce raw materials at present imported or whose products are imported. In connexion with these proposals it has been necessary to consider the reasons why these crops are not at present cultivated to any considerable extent in Australia, and in the cases of two of the most important, viz., Cotton and Flax, it has been found that the

main reason is economic and not climatic. The great importance from the Imperial point of view of an increase in the cultivation of cotton in the Empire has recently been emphasized in the Report of the Dominions Royal Commission. (See paragraph (i) (b) below.)

There seems no reason to doubt that cotton will grow as luxuriantly in Northern Australia as in any other part of the world. Indeed, during the American Civil War a considerable quantity of high-grade cotton was produced in Queensland. In normal times, however, the high cost of picking cotton by hand is the main reason why Australia has been unable to compete with other countries where the cost of labour is much less. In the case of flax also, the great amount of labour required in retting, breaking, and scutching the fibre militates against the cultivation of this crop for fibre on a large scale, though this does not appear to be the reason for the small cultivation of flax for linseed in Australia. The most hopeful method of solving these problems is, in the case of cotton, by the introduction of a mechanical picker which would obviate the necessity of hand-picking, and, in the case of flax, by the discovery of some chemical method of retting the fibre. A large number of machines for picking cotton has been patented in the United States of America, but it does not appear that any of these machines has proved really successful. The Committee has made inquiries from numerous sources in the United States, and has obtained a good deal of information on the subject. Several Australian inventors have devoted attention to the problem, and the Committee has received in confidence particulars of their inventions, which in no case are at present very complete. The difficulties in the way are great, but should not be insuperable, and the whole problem might well be undertaken by the staff of the future Institute, especially as it seems not improbable that one element in the case is the production of a variety of cotton specially suited for mechanical picking. It seems therefore possible that the plant-breeder of the Biological department co-operating with the mechanical engineer of the Physical department might ultimately solve the problem. (See paragraph (i) (a) below.)

In the case of flax, the Executive had brought to its notice a patent process for the chemical retting of the fibre by means of an extract of linseed. If the process is as satisfactory as appears probable from the accounts received by the Committee, it should be of great service in leading to a greatly increased cultivation of flax in Australia, and the Committee are considering a proposal to have the process tested on a considerable scale.

In almost all the States experiments are being conducted in wheat-breeding, especially with a view to the production of drought-resistant varieties which would enable settlement and cultivation to be pushed into the drier areas of Australia. A part of the problem which has not been so fully considered is the breeding and selection of fodder-plants suitable for rotation crops in dry areas. For this purpose a more extended study of our native salt-bushes and the grasses of the interior is desirable, together with experimental breeding of these plants. It is also important that the useful fodder-plants of other parts of the world should be introduced, acclimatised, and studied under Australian conditions. With a view to the formulation of a definite scheme for the furtherance of these objects and the co-ordination of the work on these lines at present being conducted independently in the different States, the Committee, with the approval of the Ministers of Agriculture in all the States, proposed to the Commonwealth Government in August, 1916, that a conference of experts from all the States should take place in Melbourne in October of that year. This proposal was not approved by the Commonwealth Government.

(i) *Cotton.*—(a) *Cotton Growing in Australia*—A very large area in the northern parts of Australia has a climate suitable for the growth of cotton, indeed it has been estimated by experts that this area is greater than that suitable for cotton in the United States, where at the present time two-thirds of the world's supply is produced. That high-class cotton can be grown in Queensland was conclusively proved at the time of the American Civil War, when, owing to the inducement offered by the high price of cotton, that State exported 26 million pounds of ginned cotton, worth £1,300,000. The industry was subsequently almost abandoned, but partially recovered on the establishment of a cotton mill at Ipswich, which, however, eventually had to close down.

The chief difficulty in the past which has prevented the successful establishment of the cotton industry has been the high cost of picking the cotton in Australia. This was due partly to inexperience, there being no skilled body of pickers familiar with the crop, hence the picking was slow. The high wages prevailing in Australia were, however, the chief factor. In this respect it has to be remembered that wages in the United States are steadily rising, whilst at the same time black labour is being displaced from the cotton-fields. The disparity between the cost of production in Australia and the United States is thus

tending to disappear. Authorities in Queensland consider that the best way to overcome the labour difficulty is to encourage farmers to grow small crops, say 10 acres, of cotton in addition to their other crops. It is calculated that a family of four persons could easily pick the cotton produced on this area without extra help. It has also been suggested that if the Government intend to provide ready-made farms for settlers in Queensland after the war, cotton would be a suitable crop with which to start.

Cotton-waste, a by-product of the spinning mills, is one of the chief raw materials used in the present manufacture of cordite. As the result of an article by Mr. G. S. Hart entitled "No Cotton, No Shells," published in the *Rockhampton Daily Record*, a meeting was held at Mount Morgan, presided over by the Mayor. This meeting resolved—"That a Munitions Cotton League be now formed to press forward the production of cotton in Australia, so that it may be available for the manufacture of munitions." The meeting was widely advertised in Queensland papers, and the Department of Agriculture undertook to deliver free seed to the nearest railway station. The Queensland Government also guaranteed to purchase seed cotton at 1½d. per lb. About 300 growers obtained seed and about 800 acres were planted. Unfortunately the season was unfavorable, and some of the seed available was not of very good quality, nevertheless a considerable number of the crops gave high yields.

Though the annual peace time requirement of prepared cotton-waste for the manufacture of cordite in Australia is only 60 tons, yet it is obviously of great importance that Australia should be self-contained in the matter of the production of munitions. In England the cotton-waste is specially treated in Government works, and is supplied as a product of exceeding uniformity. Before Australian-grown cotton could be used for the manufacture of service cordite it would have to undergo similar treatment, and the cordite produced would require to be submitted to exhaustive tests, both in respect to its stability and its ballistics. Stability tests to be satisfactory would extend over a number of years. Arrangements have been made for the experimental manufacture of a fairly large sample of cordite from Australian cotton. This will then be tested, and it is hoped that the results will be satisfactory.

The introduction of a mechanical cotton-picker is the most hopeful method of overcoming the difficulty due to the high cost of labour. Many machines for this purpose have been patented, but none have come into use, in spite of the fact that the invention of a simple contrivance which would enable the cotton to be picked twice as fast would make a fortune for its inventor. It is stated that the United States Department of Agriculture has spent £50,000 in experimenting with cotton-picking machines, and one American firm spent £5,000 and at last gave up experimenting. Several machines have also been invented in Australia. The American inventors have mostly produced machines which pick the cotton by means of a number of arms bearing spikes which pass over the plant. These, however, damage the plant and spoil much of the cotton which is not yet ripe, and unless a variety of cotton could be produced which ripened all its seed at once, they are not likely to prove satisfactory. The machines invented in Australia are on the suction principle, familiar in the vacuum cleaner, and to allow them to achieve their best effect it would be necessary to grow a variety of cotton in which the valves of the cotton-bolls open wide, so as to expose the cotton fully.

Australia is fortunate in that the only two cotton-pests at present established in this country are rust and the boll-worm—a species of cut-worm. The cotton-worm, cotton-stainer, and dreaded boll-weevil of the United States are unknown, and it is important that imported seed and raw-cotton should undergo rigid inspection to prevent the chance introduction of these pests.

(b) *Recommendations of the Dominions Royal Commission.**—The following extracts from the Final Report of the Dominions Royal Commission are of interest and importance:—

§362. "The dependence of the Empire, and indeed of the world, on the United States of America for the bulk of its supplies of raw cotton is too well known to need detailed comment. The United States provide, approximately, 70 per cent. of the cotton crop of the world, and the dependence of the United Kingdom upon the supplies from this source is enhanced by the fact that the major portion of British spinning machinery is specially adapted to the spinning of cotton of the American type. Moreover, there is already, generally speaking, a deficiency in the world's annual cotton crop, as compared with the world's demand, and it may be that, unless special steps are taken, this deficiency will tend to increase in the near future. The need for increasing the supplies of cotton within the Empire is therefore urgent."

§363. "It is clearly desirable that immediately circumstances permit, each of these Dominions (Australia and Union of South Africa) should proceed further with the local investigations already promised or undertaken, and in particular we urge—

- (a) That expert advice should be sought by the Commonwealth and Queensland Governments.
- (b) That further inquiries should be made, if possible by the Commonwealth and Union Governments conjointly, into the possibilities of a mechanical picker.
- (c) That the British Cotton Growing Association should continue to afford to both Governments the measures of co-operation already agreed."

4. Miscellaneous.—Several other matters connected with the agricultural and pastoral industries have also engaged the attention of the Committee, amongst which may be mentioned the suggestion to conduct a Soil Survey of Australia (see paragraph (i) below); the investigation of the stomach contents of birds, with a view to ascertaining the food of each species, thus determining whether the bird is injurious or beneficial; and the best method of branding stock to prevent the damage done to the hides by the present system of branding with hot irons (see paragraph (ii) below). In addition, certain questions referred to in other sections of this Report also have an

*Dominions Royal Commission. Final Report [Cd. 8462], page 72, 1917.

important bearing on the agricultural industry. Chief of these are the efforts made by the Committee towards increasing the supply of fertilizers. These are dealt with in Section F, Chemical Industry, hereinafter.

(i) *Soil Survey of Australia*.—The principal objects of a soil survey are to collect such scientific information with regard to the soils of a country as will permit and encourage settlement upon areas not yet occupied, or will lead to an increased yield of produce from lands already settled. Such soil surveys have been undertaken by various European countries, and with particular thoroughness by the United States of America. The results of the survey of any district are embodied in maps accompanied by descriptive pamphlets, and give the results of chemical and physical analyses of the soils, the nature of the original vegetation if still existent, the geological nature of the underlying or outcropping rocks, the surface contour, drainage, and rainfall, as well as an account of the areas devoted to various crops, the local methods of cultivation, and the history of settlement in the locality. The initiation of a soil survey in Australia was strongly urged on the Executive soon after its formation, but before taking action it was decided to obtain the opinions of the State Agricultural Departments on the matter. It appeared that there was a general consensus of opinion that the present was not a suitable time to embark on a comprehensive survey of the nature of that outlined, but it was thought that an important preliminary step which might well be undertaken at once was a collection and co-ordination of information already existing in various State Departments.

The Committee have decided to proceed with this work if they can find a suitable man to undertake it.

(ii) *Branding of Cattle*.—The attention of the Committee has been drawn by the Federated Master Tanners' and Leather Manufacturers' Association to the loss caused to hides by the careless and excessive branding of cattle. Information is being collected by the Executive Committee from various sources as a preliminary step to taking further action to obviate the loss.

C.—FOREST AND VEGETABLE PRODUCTS.

1. The Utilization of Native Vegetable Products.—The vegetation of Australia is highly peculiar, a great number of the commonest and most widely distributed plants of the continent being quite distinct from those of other countries. Many whole groups of plants, including the genus *Eucalyptus*, which includes most of our forest trees, are entirely Australian. The fact of this high degree of peculiarity in our flora renders it essential that for the full development of the forest and vegetable resources of our continent researches into the products of all our indigenous plants should be conducted. It is not improbable that work of this nature may reveal new oils and drugs of importance to mankind, new sources of dyes and tannin, or timbers specially adaptable to certain particular uses. Most of the drugs, spices, &c., of India and America were discovered and utilized by the natives of those continents before intercourse with Europe opened up a trade in these products. In Australia, however, the natives made very little use of the indigenous plants for such purposes. In the early days of settlement primitive experiments were made, and the useful properties of some Australian plants discovered. More recently definite chemical researches have been carried out on scientific lines in various States, but especially at the Technological Museum, Sydney, and much important information obtained. Nevertheless the work is still only in its infancy, and there can be no question that further researches of this nature are urgently required. They should form an important part of the work of the Institute of Science and Industry.

It must not be forgotten that chemical researches on vegetable products are practically valueless unless the plant from which the product has been obtained has been scientifically classified so as to be identifiable by its botanical name. A good deal of the work carried out in Australia in the past has been wasted owing to uncertainty as to the exact source of the material employed. Hence in this type of work systematic botany must precede chemical research. In Australia systematic botany has advanced sufficiently to allow of the proper identification of our native plants by comparison with specimens in the herbaria of the different States, but this is by no means the case with the Territory of Papua. Before that Territory's plant resources can be scientifically developed it is urgently desirable that a proper botanical investigation of the flora of the Territory should be made. The Executive Committee has therefore recommended to the Commonwealth Government that a botanist and a forester should be appointed to investigate the flora of Papua. The former would be responsible for the collection of plant specimens for the purpose of identification, while the latter would report on the quantities of valuable trees available and the best means of development.

2. Timber and Timber Products.—The problems connected with Australian timbers which urgently require research are numerous and of great importance. A great deal of information on these problems has been collected by the Executive

Committee, and it is proposed shortly to publish a summary of them in the form of a Bulletin. The matter was also urged on the Advisory Council by the Forestry Conference held in Adelaide in May, 1916. Whilst the Committee fully agree that this matter is one of great importance to Australia, they have decided that most of the researches required could only be undertaken efficiently in a properly equipped Forests Products Laboratory, and that the establishment of such a laboratory is too large an undertaking for the present body with its limited powers, but should receive consideration as soon as the permanent Institute is established.

The chief problems connected with timber which should be investigated in such a laboratory are :—

- (1) The physical characteristics of each species of Australian timber, with a view to insuring its utilization for those purposes for which it is best adapted.
- (2) The best means of seasoning each timber in relation to the specific purpose for which it is to be used.
- (3) The best preservatives for Australian timbers to prevent decay and attacks of white ant, teredo, and other timber pests.
- (4) The investigation of local timbers, with a view to the discovery of species suitable for the manufacture of wood-pulp. (See paragraph (i) below.)
- (5) Investigation of the products derived from local timbers by the process of dry distillation, and the relationship of the products obtained to the temperature and pressure conditions of the distillation process. (See paragraph (ii) below.)
- (6) The best means of utilizing the waste from the timber mills. (See paragraph (iii) below.) This last inquiry would probably involve some of the foregoing, as it is possible that the best use for the waste from some species of timber might be by distillation, of others by pulping, and of others by utilization of the shorts for cabinet-making, manufacture of chairs, brush-handles, &c. The best means of utilizing sawdust would also require consideration.

(i) *Wood-pulp*.—As far as the Committee have been able to ascertain the only plant erected in Australia for the manufacture of wood-pulp is that belonging to the Queensland Pine Co. Ltd., at Yarraman Creek. At this mill hoop pine (*Arucaria cunninghami*) and bunya bunya (*A. bidwilli*) were treated by the sulphate process, and a good type of wood-pulp prepared, which obtained a ready sale. The mill had to close down in 1916 owing to lack of water, and has not been re-opened. The company state that some form of assistance to the enterprise by the Federal Government would be necessary to induce them to restart operations.

In 1915, Mr. H. E. Surface, Consulting Engineer in Forest Products, Madison, Wisconsin, U.S.A., visited Tasmania at the request of the Tasmanian Government to investigate the possibility of establishing the wood-pulp industry in that island. From considerations as to relative quantities available, accessibility, &c., the inquiry was limited to four species, viz. :—Myrtle or beech (*Fagus cunninghami*), swamp-gum (*Eucalyptus regnans*), bluegum (*E. globulus*), and stringybark (*E. obliqua*). Mr. Surface reported* that the utilization of these four timbers for the manufacture of wood-pulp and paper products is not a feasible business proposition. Mr. Surface has since informed the Executive Committee that he considers that there is quite a possibility of building up the wood-pulp industry through the use of native woods other than those reported on by him, and he urges that the matter is of sufficient importance to warrant a thorough survey of Australia's paper-making resources. If suitable native woods are not forthcoming he considers that careful attention should be given to the question of planting suitable trees. He adds—"Even in this country (America), with its former wealth of timber, we see the planting of lands to pulp-wood species in the eastern and the older or more settled regions. Forty or fifty years from now, when pulp-wood species planted now would first be harvested, may be a time when the need for paper-making supplies is indeed very acute. When Australia looks ahead for forty or fifty years, doubtless it will see a very great increase in population and a shortage in paper-making materials in other parts of the world from which it formerly drew its supplies."

The Committee has been informed that some years ago the Australian Paper Mills Co. prepared some excellent wood-pulp, utilizing the filamentary waste of the mountain-ash (*Eucalyptus regnans*). [N.B.—This was one of the timbers on which Mr. Surface reported adversely.] Other timbers which have been suggested to the Committee as likely to be suitable for pulping are the celery-top pine (*Phyllocladus rhomboidalis*) and huon pine (*Dacrydium Franklini*) of Tasmania, and the candlenut (*Aleurites moluccana*) of Queensland. It has also been suggested that if any hardwoods are suitable the most likely are those which readily split into palings, such as the messmate and the silky oaks (*Grevillea*). The Queensland Pine Co. experimented with ironbark, spotted-gum, crowfoot, and yellow-wood, and found them unsuitable.

The Executive is collecting through the State Committees information regarding native trees that offer a *prima facie* case for investigation for pulping qualities.

* Parliament of Tasmania, 1915, No. 8.—B. 64115.

(ii) *Destructive Distillation*.—In Europe and America a large amount of hardwood timber is utilized for the production of charcoal by dry distillation, the other products obtained in the process being wood spirit (methyl alcohol), acetic acid, tar, and inflammable gases. There is no reason to suppose that the hardwoods of Australia are in any way inferior in their yield of these products compared with the hardwoods of other countries, and tests made at the Forest Products Laboratory, Madison, Wisconsin, U.S.A., with bluegum (*Eucalyptus globulus*) grown in California showed that it compared favorably with the standard American species beech, birch, and maple. Details as to tests of some New South Wales timbers made by Mr. F. B. Guthrie were published in the *Agricultural Gazette* of New South Wales, in October, 1898, and give results of distillation of stringybark, yellow-box, peppermint, messmate, brittle-gum, spotted-gum, mountain-ash, and bluegum. Mr. C. Gadeke has supplied the Executive with particulars of experiments carried out by him on Victorian timbers in 1896-7, showing the yields obtained from messmate, sheoak, white-gum, wattle, stringybark, peppermint, ironbark, box, blackbutt, and blackwood.

Messrs. Cuming, Smith, and Co.'s works at Yarra Junction, Victoria, and Mr. J. V. Vale's works at Wyce, New South Wales, are at present the only works in Australia distilling timber as far as the Committee can ascertain. The former firm's works have been in operation for a number of years, during which they have distilled all available eucalyptus timbers, and they report that the yield from all the species is very similar. There are, however, certain difficulties in treating eucalypts which are not present in the case of European and American hardwoods, and a serious obstacle to the development of the industry is the lack of markets in Australia for many of the chemical products of distillation and the comparatively small demand for charcoal. Mr. Vale's works have only recently commenced operations, and have at present dealt with swamp oak (*Casuarina glauca*), the yield from which is satisfactory. The New South Wales Forestry Commission has arranged with Mr. Vale to have tests made on 1-ton samples of about 30 other timbers, and the results of these experiments will be published. Mr. Surface has drawn special attention to the fact that in the so-called myrtle (*Fagus cunninghami*) of Tasmania and Victoria, Australia possesses a true beech closely akin to the beeches of Europe and America, whose timber is one of the main raw materials used in those countries in the distillation industry.

(iii) *Utilization of Waste Timber*.—The Executive has received two reports on this subject from Mr. C. E. Lane-Poole, Conservator of Forests in Western Australia, which indicate that the waste in karri timber amounts to 67 per cent. and in jarrah to 53 per cent. of the sawn timber, whilst the remaining portions of the trees—crown and limbs—are also wasted. In the year 1913, for instance, 218,908,000 super. feet of sawn timber were produced in Western Australia out of 562,594,000 super. feet felled. Apart from rotten hearts, &c., useless for any purpose, and timber used as fuel for boilers, 240,580,200 super. feet of potentially valuable timber were entirely wasted, and in order to consume this waste expensive fire-shoots are maintained by the timber mills. Though the waste in other States is not so large as in Western Australia, it is evident that means for utilizing this waste urgently require investigation. It is not likely, as already indicated, that eucalyptus timbers can be profitably utilized by pulping; the possibilities of distillation are more favorable, though, as pointed out above, the market in Australia for the products of distillation is not very large. Attention should be given to the utilization of shorts for the manufacture of small wooden articles, such as vehicle parts, chairs, brush handles, insulator pins and brackets, floor blocks, and reels and bobbins for thread.

3. Sources of Tannin.—The supply of tan-bark for use in Australian tanneries has for many years past been obtained mainly from two species of wattle—the Golden Wattle (*Acacia pycnantha*) of South Australia, and the Black or Green Wattle (*Acacia decurrens*) and its varieties. As a result of the gradual destruction of wattle-trees the Australian supply has become inadequate, and has been largely supplemented by wattle-bark imported from Natal, where plantations have been formed by the utilization of Australian seed. Owing to the cheap labour available in South Africa, and the fact that the wood from the wattles is in demand for firewood in that country, where timber is scarce, there seems little chance of Australia being able to compete with Natal in the production of wattle-bark. In addition to the wattles, a valuable tan-bark is yielded by the Mallet (*Eucalyptus occidentalis*) of Western Australia, but though the useful properties of this bark were only discovered in 1903, its exploitation was so rapid that only comparatively small quantities now remain.

It is obviously a matter of great importance to insure a local supply of tannin for the future, and four possible means of doing this have been suggested, viz. :—

- (1) Regulation of bark collecting to prevent the destruction of young trees, and thus secure the maximum amount of bark. This matter has already been considered in most of the States, and regulations are in existence, but are very difficult to enforce owing to the great areas over which the trees are spread and the small staffs of the Forestry Departments.
- (2) Plantation of wattles for the production of bark. Many such plantations were formed some 30 years ago, when estimates of prospective returns were published which made the industry look attractive, but experience has shown that owing to the slow growth of the trees and the great danger from bush-fires wattle-plantations are not successful in Australia.

(3) Discovery of new sources of tannin. The Executive has collected information from all the States as to analyses of barks, from which it appears that barks of about 150 species of Australian trees have been analyzed as to their tannin content, and fifteen have been found to average over 20 per cent. of tannin. Of these, nine are wattles, but, except for the two species already mentioned, they are not very abundant trees, though some of them are utilized locally to some extent. Two are Cypress-pines, and one of these (*Callitris calcarata*) is a plentiful tree in Eastern Australia, and is utilized to some extent. Three are Mangroves, but the bark from these trees has hitherto not been utilized to any extent in Australia, owing to the fact that mangrove-bark contains a dye which gives a red colour to the leather. In view of the great area of coastline in Northern Australia and New Guinea on which mangrove swamps occur, the Executive has appointed a Special Committee to consider the best means of utilizing the bark and possible methods for decolourizing the tan-liquors obtained from it. (See paragraph (i) below.) The remaining species is the Mallet, already referred to. In addition, the kino (gum) produced by the Redgum of Western Australia (*Eucalyptus calophylla*) contains a high percentage of tannin, which is also present in the kino-saturated portions of the bark. As in the case of the mangrove, a dye is also present which stains the leather a red colour, and largely prevents the use of this bark for tanning purposes. The Redgum is a very abundant tree in Western Australia, and the Executive has appointed a Special Committee to investigate the whole question. (See paragraph (ii) below.)

(4) Manufacture of tannin extracts. This is perhaps the most promising solution of the shortage of tanning materials, as it allows of the utilization of leaves, twigs, &c., as well as of barks containing too little tannin to be used directly. It would be a means of avoiding the great amount of waste involved in the present methods of collecting wattle-bark, in which the tree is cut down and the bark stripped from the trunk whilst the smaller branches and twigs are not utilized. Extracts have been prepared from wattle-twigs, &c., by several Australian firms, but one of the difficulties is that gums and dyes are also extracted in the process, and the extracts have to be decolourized, whilst the presence of the gums is detrimental. Before the war large quantities of Australian barks, including those of wattle, mallet, and mangrove, were utilized in Germany for the production of extracts, and these German extracts were imported into Australia. Chemical research in Germany had solved the problems of decolourization and of the removal of undesirable gummy matter, and these problems should be investigated in Australia.

An inquiry as to methods of tanning, which is being undertaken by a Special Committee appointed by the Executive, is referred to in section "G" of this Report.

(i) *Mangroves*.—This name is given to those trees which grow in salt water on the coasts of tropical and sub-tropical countries. They are very plentiful on a great extent of the northern coastline of Australia, as well as on the coasts of Papua. The commonest species are members of the family *Rhizophoraceæ*, and the bark of several of these has a high tannin content. Mangrove bark, however, suffers under the disadvantages of producing too red a colour, a disagreeable odour, and inferior leather, and it is liable to contain an excess of salt. The statements received by the Executive on these points are, however, conflicting, and it is possible that the different reports are due to differences between the barks of different species. Large quantities of mangrove-bark were formerly shipped to Germany from West Africa, Burma, New Guinea, and other countries, and a widely-used tannin extract was prepared from it. The Executive therefore appointed a Special Committee to investigate the tannin contents of the different mangrove barks available in Queensland, the extent and accessibility of suitable mangroves, the best methods of extracting the tannin, including methods of bleaching, the tanning qualities of extracts, and the costs and commercial prospects of the industry.

(ii) *Western Australian Redgum*.—This species of *Eucalyptus* (*E. calophylla*) is very plentiful in Western Australia, to which State it is peculiar. The kino (or gum), which exudes from the tree in considerable quantities, is very rich in tannin, and bark saturated with kino is a valuable tanning material. The collectors do not strip the bark from the tree, but scrape it, so that the tree is not killed in the process, but may be scraped again and again. It may be found possible to increase the yield of tannin by perforating the bark or resorting to some similar operation to promote the flow of kino. A serious objection to the utilization

of redgum is the fact that it colours the leather red. Mr. B. Rosenstamm, of the Perth Tanneries, has been trying for some years to solve the problem of decolourizing it, without success. The Executive has appointed a Special Committee to investigate all aspects of the problem.

4. Other Vegetable Extracts. The Executive Committee has received numerous suggestions as to possible methods of utilizing several native Australian vegetable substances.

(i) *Dyes*.—A number of correspondents have prepared dyes of brown and khaki shades from mangrove bark, and similar dyes have been prepared from the resin of the grass-tree and from eucalyptus barks. The Committee were considering the appointment of a Special Committee to investigate native plants, with a view to their utilization as sources of dyes, when they were informed that the Government of New South Wales had arranged to appoint two additional assistants at the Technological Museum, Sydney, with the special object of enabling Mr. H. G. Smith to continue his researches on this subject.

(ii) *Camphor*.—The attention of the Committee was drawn to the fact that the Camphor-laurel (*Cinnamomum camphora*) is commonly cultivated in Queensland, and it was suggested that it might be utilized for the production of camphor. A native Queensland tree known as the Sassafras (*Cinnamomum oliveri*) has also been shown to contain camphor. A special committee in Queensland is making an investigation of this question.

(iii) *Grass-tree*.—A number of trees belonging to the genus *Xanthorrhoea*, which is peculiar to Australia, are included under the name of Grass-trees, and all produce large quantities of resin known as Yacca Gum, Blackboy Gum, or Gum Acaroides. This substance was formerly used for the manufacture of picric acid, but cannot compete for this purpose commercially with phenol, which is derived from coal-tar. The gum has also been utilized in the manufacture of varnishes, stains, and dyes. Previous to the war a very considerable quantity of the gum was exported to Germany, chiefly from Kangaroo Island, but it is not known for what purpose it was used in that country.

Numerous investigations of this substance have been carried out both in Australia and in England, chiefly in connexion with its utilization as a source of picric acid and for the manufacture of varnish. Up to the present, however, the chemical composition of the grass-tree resins has never been determined, and the Committee considers that a fundamental research of this nature is desirable. They have accordingly appointed a Special Committee in Adelaide to undertake this work, and have recommended that a grant of £50 be made for the purchase of chemicals, &c.

Suggestions have been made for the utilization of other parts of the grass-tree, e.g., the tissues of the stem for the production of alcohol and the leaves for paper-making, and these possibilities also require scientific investigation.

D.—FISHERIES.

1. General.—It is generally admitted by all who have studied the question that the marine resources of Australia are not at present utilized to an extent at all comparable with their prospective value. This was recognised by the Commonwealth Government some years ago, and as a result the trawler *Endeavour* was built, and spent some years exploring parts of the coastline for grounds suitable for trawling. Unfortunately, the *Endeavour* was lost at sea in 1913, and the Commonwealth has since made no further investigations of its fisheries. The work accomplished by the *Endeavour*, however, led the New South Wales Government to purchase several trawlers, and was thus the means of starting in Australia an industry which gives employment to large numbers of men in other countries.

Even though Australia takes so small a toll of fish from her waters, there is considerable evidence that certain species have already been depleted, and are much less plentiful in some areas than they were formerly. Fishery legislation at present is entirely empirical, as practically nothing is known as to the seasons of reproduction, rate of growth, and other important facts in the life-history of Australian marine fishes. To obtain this knowledge the establishment of a marine biological station with a proper aquarium has been suggested to the Committee, which is obtaining reports on the subjects from Professors W. A. Haswell and Sir Baldwin Spencer.

2. Tropical Fisheries.—A number of fisheries for different marine animals are carried on in the northern waters of Australia. Of these, much the most important is pearling (see paragraph (i) below), but minor fisheries exist, or might be established, for bêche-de-mer (paragraph (ii)), trochus (paragraph (iii)), sponges (paragraph (iv)), turtles, and dugong, whilst the best means of curing or preserving Australian tropical fishes so that they could be utilized as an addition to the food supply of our southern cities is worthy of careful consideration. The Executive has referred all these questions connected with the marine biological economics of Tropical Australia to a Special Corresponding Committee consisting of marine biologists in Western Australia, Queensland, and New South Wales. This Committee has collected a considerable

amount of information as to the industries concerned, but most of the necessary researches will involve special visits to suitable northern localities, and it is not likely that biologists capable of undertaking the work will be available till after the war.

(i) *Pearling*.—This important industry is in a constantly fluctuating state, and several reports on it have been made by Committees and Commissions. Most of these agree that legislation has been applied erratically and unfavorably to the industry, and this seems inevitable until expert investigation on the life-history of the Australian pearl oysters and the modes of formation of pearls have been undertaken. This has been realized in Japan, where a large amount of work on this subject is being carried on, as well as in Ceylon. In the latter case inquiry was only begun when a sudden disappearance of the oysters led to a collapse of the industry. Expert opinion was then called in, but as research on these subjects is bound to be long and arduous, and the experts had to familiarize themselves with the local conditions, it was too late for anything to be done. With the experience of Ceylon as a warning, it is obviously highly desirable that Australia should investigate the conditions prevailing on the pearl banks in order that scientific advice may be available if any similar catastrophe should threaten the Australian industry. Money spent on such investigations should be regarded as expenditure on insurance.

Investigations should aim at gaining some knowledge of—

- (1) The conditions under which the pearl oysters live and flourish—could they be transplanted to shallow water; could they be transplanted to special “parks” and cultivated?
- (2) Reproduction and life-history of the pearl oyster.
- (3) Deposition of spat, and part played by ocean currents in distribution of spat.
- (4) Methods of formation of pearls and possibility of artificial stimulation of pearl-production.

Should cultivation of pearl oysters be found possible, it might provide subsistence for a large and permanent fishing population, whereas diving by licence attracts a nomad population only. Professor W. J. Dakin, of the University of Western Australia, who was formerly connected with inquiries into the Ceylon Pearl-fisheries, has been asked to undertake researches in North-western Australia on these problems.

(ii) *Bêche-de-mer*.—This is the name commonly applied to certain species of Holothurians or Sea-cucumbers, which are found in warm seas, and, when dried, are known as trepang, and utilized, chiefly in China, for the production of soup.

On certain parts of the northern coasts of Australia these animals are plentiful, and they were fished for by Malays on the Australian coast before the European settlement of the continent. The fishery for these animals is not regulated, and after a locality has been fished it is some years before it can be fished again.

The Special Committee suggest that a trained zoologist should be engaged to study the reproduction and early life-history of the animals, points which are at present almost unknown.

(iii) *Trochus*.—This is a sea-snail coloured red and white, whose shell is the size and shape of a top. The shells are gathered on the reefs at low tide by Japanese, and exported for the manufacture of buttons. Naturally, the Japanese take every shell when and where they find it, and it is a question whether the shell may not thus be exterminated. The Special Committee has received a series of *Trochus* shells, and much valuable information from a number of localities. This material is being studied by Mr. C. Hedley, of the Australian Museum, and promises results of interest. Mr. E. J. Banfield has arranged to keep living *Trochus* on his coral reef at Dunk Island, and to ascertain their rate of growth by observation.

(iv) *Sponges*.—It is known that the Australian coast is very rich in sponges, yet Australia is entirely dependent on the Mediterranean, West Indian, and Bahaman fisheries for her supply of sponges for domestic and commercial purposes. It is not at present known whether, amongst our local sponges, varieties of economic importance are present in any quantity, and this is the first point to merit investigation. As a result of preliminary inquiries by the Special Committee, samples were forwarded by the Cooktown Chamber of Commerce of a sponge found in considerable numbers in shallow water on the Great Barrier Reef. This was identified as the “Hardhead” sponge of Cuba and the Bahamas, and is a variety in much demand for industrial purposes, such as cleaning motors. It is hoped that this may replace lower-grade sponges now imported. Should it prove on investigation that commercial sponges do not occur on the Australian coast in sufficient quantities to enable a profitable fishery to be established, the question of introducing valuable varieties of sponges from other countries will demand consideration. Another question for inquiry will be the prospects of cultivating either indigenous or introduced sponge species in Australia. Particulars as to sponge-culture in other countries are being collected to serve as a foundation for this inquiry.

E.—MINING AND METALLURGY.

1. Metals.—The immediate need for researches on problems connected with mining and treatment of metals does not appear to be so great as in the case of other primary industries. This is doubtless due to the fact that a large proportion of Australia’s metal output is produced by companies with a large capital, which has enabled them to maintain their own research laboratories and staffs of qualified chemists and metallurgists. Nevertheless, there is wide scope in Australia for investigational work, with a view to developing new or improved processes, especially for the treatment of low-grade ores, and determining the properties of various alloys.

One of the matters originally suggested to the Committee as requiring immediate consideration was the question of the best means of extraction of zinc from its ores, with special reference to the electrolytic process. Since the Committee was formed,

however, it has become common knowledge that the Amalgamated Zinc Co. have taken up the problem of the electrolytic extraction of zinc, and that, as a result, the Electrolytic Zinc Co. has been formed and has made arrangements for carrying it out on a large scale. The Committee, therefore, came to the conclusion that no action was necessary in this matter.

Another matter suggested for the early consideration of the Executive was the production of ferro-alloys for high-speed steel. It was ascertained that research on this problem had already been begun by Messrs. A. J. Higgin and E. B. Brown (Lecturers on Metallurgy and Electrical Engineering respectively at Melbourne University) under the auspices of the Federal Munitions Committee, and a request was received from that body that further financial assistance for this work might be given by the Advisory Council. This was granted, and the work has since proceeded as a research by a Special Committee of the Advisory Council. Towards the end of the year Mr. Brown left for England to undertake munition work, and Mr. W. N. Kernot, of the Melbourne University Engineering School, took his place as an associate with Mr. Higgin in the inquiry.

Up to the present the work has been confined to investigations of the manufacture of ferro-chrome and ferro-tungsten, the most important alloys in the manufacture of high-speed steel. The experiments on the manufacture of ferro-chrome prove that there is no difficulty in manufacturing this alloy at a reasonable cost, providing a sufficiently cheap source of electric supply is available. Ferro-tungsten has presented more difficulties, and the Committee is not yet able to give final conclusions as to the best method to adopt in its manufacture, but hopes to complete this portion of its inquiry within a few weeks. (See paragraph (i) below.)

Another question referred to at the initiation of the work of the Advisory Council was the production of aluminium in Australia. The Committee has made some inquiries on this matter, but owing to the classification adopted by the Customs Department, it has been unable to obtain any information as to the amounts of aluminium or aluminium ware imported into Australia, aluminium being grouped in the returns with a large number of other metals. A profitable source of aluminium is the mineral alunite, which has hitherto been utilized for the production of alum. The best methods of utilizing this mineral for the extraction of potash and alumina have formed the subject of the investigations of a Special Committee (see page 34). Other questions connected with aluminium have been referred to the Special Committee on Chemicals.

As the result of an interview with Professor E. W. Skeats, Professor of Geology in Melbourne University, the Executive decided to appoint a Special Committee to investigate the mode of occurrence of gold in quartz in Australia, with a view to determining the principles which have led to the localization of payable gold, and thus, among other things, cheapen the cost of deep prospecting. It was decided to commence operations by the study of the Bendigo Gold-field, and Dr. F. L. Stillwell was appointed secretary and salaried officer of the Committee to devote his whole time to the work. Dr. Stillwell commenced work on 2nd August, 1916, and has visited nearly all the active mines on the field, making altogether 118 inspections. He has also carried out a large amount of microscopical work and consultation of literature in relation to the work. Members of the Special Committee have also visited Bendigo three times during the year and together inspected eight mines. The tentative conclusions at present reached as to the origin of the gold deposits indicate the possibility of yielding some assistance to prospecting in the future. (See paragraph (ii) below.)

(i) *Manufacture of Ferro-Alloys.*—Ferro-chrome is made by smelting chrome iron ore with an excess of carbon in an electric furnace. This produces crude metal, containing about 10 per cent. of carbon. The crude alloy is then refined by smelting in the electric furnace with chrome iron ore. This brings about the oxidation of the carbon, and yields an alloy suitable for the manufacture of "high-speed" steel. The experiments on the manufacture of ferro-chrome prove that there is no difficulty in the production of this alloy at a reasonable cost, providing a sufficiently cheap source of electric supply is available.

Ferro-tungsten is made by the reduction of sufficiently pure wolfram, which is the principal tungsten ore, with carbon, or of tungstic oxide mixed with pure hæmatite or metallic iron and carbon in the electric furnace.

A very pure alloy has been made by the reduction of wolfram ore with carbon in the electric furnace, but the yield was very low, owing to the fact that the ore contains manganese, and that a prolonged treatment was necessary in order to volatilize that impurity.

A number of experiments have been made with charges of wolfram ore and carbon, with a view to ascertaining whether it would be possible to produce a pure alloy direct from the ore without an excessive loss of tungsten.

The Committee has succeeded in reducing the loss of tungsten to 1 per cent., but the alloy produced was very impure, containing too much manganese, silicon, and carbon. Some of this alloy was refined by smelting in the electric furnace with hæmatite iron ore, lime, and fluor spar, but the refined metal was still too impure for use.

As the ores of tungsten are liable to contain impurities which become reduced together with the iron and tungsten in the electric furnace, thus rendering the alloy impure, it was thought that more satisfactory results would be obtained by the use of pure tungstic oxide instead of wolfram ore. A number of experiments have been made with pure tungstic oxide, and so far the results obtained confirm this opinion. The pure tungstic oxide was made by fusing the wolfram ore with sodium carbonate, extracting the sodium tungstate with water, filtering and decomposing the sodium tungstate with hydrochloric acid. The tungstic oxide thus produced was washed till free from salt, and dried. A small charge of the tungstic oxide was then mixed with carbon and iron, and the mixture reduced in the electric furnace. The alloy produced was very pure, much purer than that last made by the direct reduction of wolfram ore, but it is more expensive to produce, owing to the cost of preparing the pure tungstic oxide. The Committee is now making experiments on a large scale, and hopes in the course of the next few days to arrive at a comparison of the cost of production by the two methods mentioned. It is not possible in this short summary to give any details concerning the construction of the electric furnaces which have been used in carrying out these investigations, but it may be mentioned that many difficulties were met with and had to be overcome before getting them to work in a satisfactory manner.

(ii) *Occurrence of Gold in Quartz.*—*Problems of the Bendigo Gold-field.*—The ultimate problem whose solution is sought is the reason or explanation of the modes of occurrence of gold “shoots” in quartz bodies, so that the most economical methods for prospecting such shoots may be determined. This question is bound up with the origin of the quartz veins and of the mineralized solutions from which the veins were formed. It is also concerned with the structure of the rocks of the area, the structure of the veins, and the effects produced by faulting. As a result of the detailed studies of structure by the officers of the Geological Survey and others, a great amount of structural information has been collected. It was therefore recognised that results of economic value would be most likely to arise only after the problems presented in structural geology had been carefully considered and discussed in combination with the chemical, mineralogical, and petrological aspects of the problem. While no opportunity has been missed by Dr. Stillwell in studying each relatively rich occurrence of gold that has been worked in Bendigo during the last year, and its possible relations to adjoining rocks, to fault planes and to associated minerals, much of his time has necessarily been spent in getting a general grasp of the field and in forming a scientific conception of the modes of origin of the veins.

The following tentative conclusions have been reached by the Special Committee:—

The mineralizing solutions are believed to be derived from a granitic magma, and to have traversed the fault planes or slides chiefly in a vertical direction, and the reef channels chiefly in a lateral direction. The legs of the saddle reefs are regarded as fracture zones, in which the veins are formed mainly by the replacement of country rock by the solution migrating from the slides. The caps of the saddles and most spurs are believed to be mainly cavity fillings, and only to a limited extent to be due to replacement. Hitherto no satisfactory evidence of replacement has been recorded in the Bendigo gold-field. The laminated stone in the “legs,” which is frequently the quartz of highest gold value, appears to be formed, not by the scaling of laminæ of slate from the walls of a fissure, as previously suggested, but the laminæ represent the insoluble and largely carbonaceous residue of a bed of slate remaining after replacement. The frequent occurrence of gold on the laminæ is thus attributed to the precipitating effect of a carbonaceous material. Bands of carbonates, largely ankerite, a carbonate of iron, magnesium, and lime, frequently occur associated with the laminæ or “dirt lines” in the leg reefs, and there is some evidence of a causal connexion between such occurrences of gold, ankerite, and “dirt lines.” Twenty-six assays of “pug” from the fault planes or slides show that every sample assayed contains some gold, usually a few grains per ton, but ranging up to 2 ozs. in one assay. This occurrence is suggestive, and leads to the tentative conclusion that the slides are the channels along which mineralizing solutions travelled.

These tentative conclusions indicate the possibility of yielding in the future some assistance to prospecting, and are sufficiently encouraging to warrant the much more extended work which will be necessary before positive conclusions can be expected.

2. Non-metals.—Two main lines of inquiry have occupied the attention of the Committee in connexion with minerals other than metals and metallic ores. One of these is the possibility of stimulating prospecting for minerals hitherto not found or only found in small quantities in Australia, but whose products are at present imported from other countries. In this connexion the Committee has made inquiries as to the probability of finding rock phosphates (see page 34) and mineral oils in Australia. The other series of problems are those connected with the utilization of materials of which large deposits are known to occur in Australia, but which have not hitherto been fully utilized. Under this heading information has been collected in connexion with brown coal, iron, and aluminium phosphates, alunite, and clays.

The scientific problems connected with the utilization of these minerals are mainly chemical, and the work on alunite and phosphates is dealt with in the chemical section of this Report (page 34). Clays are dealt with in connexion with the pottery industry on page 38. In regard to brown coal, the Committee collected a large amount

of information, but had not taken further action when it was learnt that the Victorian New Industries Committee and the State Government were taking active steps to promote its utilization. All the information collected by the Executive was handed over to the New Industries Committee.

An inquiry was received by the Committee from Queensland as to the possibility of ascertaining the presence of opal in matrix without breaking the latter, a process which often results in spoiling the enclosed opal. It was suggested that X-rays might solve the problem, and Professor T. H. Laby, of Melbourne University, undertook to conduct experiments on the subject. Up to the present, however, owing to the practical cessation of opal-mining in Queensland, no matrix has been obtained.

F.—CHEMICAL INDUSTRY.

1. General.—A large number of chemical questions have come before the Executive, and it was thought desirable at an early stage of the work to appoint a Special Committee to investigate and report on the possibilities of local manufacture of chemicals now imported. In many cases this has further involved the collection of information as to possible Australian sources of supply of the necessary raw materials. Since the Special Committee on Chemicals was first formed, several further questions have been referred to it by the Executive, and it has thus become in fact, if not in name, a Standing Committee.

While concerned with the manufacture of chemicals generally, the Committee confined its inquiries in the first instance to the possibility of producing locally the so-called heavy chemicals. It was thought that the inquiries into the fine chemical business could be dealt with at a later date. At the outset of its work the Committee found it necessary to consult frequently the Customs reports, and it soon became clear that owing to injudicious grouping of statistics relating to chemical imports, the information required was often not available, and it was considered that steps should be taken to make the reports more useful. Quite recently the Committee recommended to the Executive that a Special Committee be appointed to report on the matter, and the recommendation was carried into effect. After careful consideration the Committee drew up a revised list, a copy of which has been sent to the Comptroller of Customs, with a request that he will meet the Committee, with a view to discussing the revised list and, if it is adopted, drawing up the necessary book of instructions for the guidance of the Customs officers.

Many of the questions referred to the Chemical Committee have been found to present no unsolved scientific or technical problems, the difficulties being alleged to be mainly fiscal or economic.

Numerous inquiries have been made in regard to the establishment of alkali works here. Caustic soda and soda ash are necessary in very many chemical processes, and this country must have an abundant and relatively cheap supply of these if chemical industries are to be established and maintained. The methods of producing these substances are well known, but in order to produce them at a price comparable to pre-war European prices works would have to be established on a very large scale, and the output of such works would be equal to the amount consumed in Australia. It is obvious that if more than one company undertakes the manufacture of alkali here the chances of making the enterprise a success are considerably reduced, owing to the very limited market in Australia. This applies not only to the alkali industry but to many other chemical industries. The Committee has been informed that a large chemical company is seriously considering the establishment of an alkali works in Australia.

2. Fertilizers.—Australia is largely dependent on outside sources for the raw material of artificial fertilizers, and the Executive Committee have devoted much attention to the consideration of possible local sources of phosphates, potash, and nitrogenous fertilizers with a view to reducing this dependence of our agriculture on foreign countries.

Of most pressing importance is the need for developing local sources of potash, since Australia, in common with the rest of the world, was before the war dependent on the potash deposits of Stassfurt, Germany, for her supply of this chemical. Besides the use of potash for fertilizers, it is required in various secondary industries, such as the manufacture of soap, cyanides, explosives, and fireworks. The problem is not peculiar to Australia, and the Committee have obtained reports and other information

as to the inquiries into new sources of potash which have been conducted in the United Kingdom and the United States of America. The sources of potash which have been suggested are—(a) alunite ; (b) kelp ; (c) suint ; (d) molasses ; (e) wood-ashes ; (f) ground igneous rocks ; (g) saline deposits.

(a) Alunite is a mineral consisting of the sulphates of potassium and aluminium, of which there is a very large deposit at Bullahdelah, in New South Wales, and smaller though purer deposits in South Australia. The Bullahdelah deposit was formerly mined and shipped to England for the manufacture of alum, but this industry is now at a stand-still. A Special Committee was appointed by the Executive to consider the best means for utilizing alunite, of which the Australian deposits are the most extensive in the world, specially with a view to ascertaining the best treatment for the extraction of the potash. This Committee has almost completed its labours, and a comprehensive report on alunite will be ready for publication in a few months. (See paragraph (i) below.)

(b) The large brown seaweeds known as kelp contain a considerable quantity of potash, but species from different localities vary considerably in their content, and few investigations appear to have been made as to the composition of Australian seaweeds. It is understood that kelp is regarded in the United States as one of the most promising sources of potash, and that large plants are being established on the Pacific Coast for its treatment. The kelp of the Atlantic Coast, however, is not nearly so favorable owing to its lower yield. From press reports it appears that a small plant for treating kelp has been established in Tasmania, and is producing potassium chloride. The Committee are making further inquiries on this subject.

(c) Suint, or wool-grease, contains a certain amount of potash, and if the whole Australian wool clip were scoured in Australia and the potash extracted, this would probably suffice for local needs. Various methods of wool-washing are in use in different countries ; in some cases the potash is first washed out with water, the fats being subsequently removed ; in other processes the grease and potash are removed together and the potash subsequently recovered. The recovery of potash in wool-scouring must be considered in connexion with the production of lanoline (page 35).

(d) The recovery of potash from molasses has been considered by a sub-committee of the Queensland State Committee appointed to review the possible means of utilizing molasses. They had before them details of a proposed method, which had been brought before the Executive Committee, for absorbing the molasses with megass, producing charcoal and gas therefrom, and then burning the charcoal to an ash from which the potash could be recovered. They reported that all methods hitherto tried for recovery of potash from molasses have led to only small proportions being finally recovered, and that the prospect of burning to ash with megass did not appear at all promising, even in war-time.

(e) The extraction of potash from the wood ashes of saw-mills and of eucalyptus distillation plants has been suggested, and the Executive Committee has collected evidence on the subject which points to the conclusion that the amount of potash is too small to render this a commercially profitable source. It is understood that experiments are being conducted as to the feasibility of extracting the potash from the ash left when prickly pear is burnt.

(f) The utilization of ground igneous rocks as potash fertilizers has often been discussed, particularly in the United States. These discussions have related chiefly to orthoclase feldspars or orthoclase-bearing rocks, but it was suggested to the Committee that leucite-bearing rocks might be more suitable from this point of view. The subject was referred to the Chemical Committee, which came to the conclusion that these rocks were unlikely to be able to compete with alunite as a source of potash.

(g) The most satisfactory solution of the potash difficulty would be the discovery of a saline deposit in Australia rich in potash salts. It seems not improbable that such a deposit might exist in some of the lake-basins of Central Australia, and it is worth consideration whether an investigation of the deposits in the beds of the salt-lakes of the Commonwealth should be undertaken.

The possibility of increasing the local supply of phosphatic fertilizers depends on either (a) the discovery locally of rock phosphates suitable for the manufacture of superphosphates, or (b) the discovery of means whereby the phosphates of iron and aluminium, of which there are considerable deposits in Australia, can be made available as sources of phosphorus to crops.

The Executive Committee has made inquiries in all the States as to the likelihood of discoveries of rock phosphates, but the replies received are not very encouraging. Islands off the coasts of North-western Australia and Queensland are regarded as the most probable localities to search, and prospecting in these localities should be encouraged. The known deposits of calcium phosphate on the mainland are small. Experiments as to the fertilizer value of iron and aluminium phosphates under different conditions are in progress in Victoria and Western Australia, and the Committee is considering the appointment of a Special Committee to co-ordinate these researches.

The question of the production of nitrates from atmospheric nitrogen has also been considered. It is well known that large plants have been established in Germany for the utilization of atmospheric nitrogen, without which the manufacture of explosives would be impossible in that country, owing to the British blockade having cut off the supply of Chili saltpetre. The utilization of atmospheric nitrogen, to be commercially successful, depends on the presence of a cheap source of power, and it seems possible that ultimately the Tasmanian hydro-electric scheme may be utilized for this purpose. Three different processes are at present in operation in other countries, but under present conditions it is impossible to obtain evidence as to which of these should be established in Australia, and it is certain that an expert familiar with them would need to be employed in the establishment of plant for the purpose in Australia. The Committee have come to the conclusion that, as there is no immediate prospect of Australia being cut off from the supply of Chili saltpetre, the matter should be left until the conclusion of the war.

(i) *Alunite*.—Alunite is a mineral occurring in large quantities in several of the Australian States, but principally in New South Wales and South Australia. In South Australia there are two important deposits of high-grade mineral, namely, at Carrickalinga and Warnertown, the former consisting of considerable masses, remarkably pure and uniform in character. There exists in New South Wales, namely, at Bullahdelah, a small mountain range which consists for the most part of impure alunite. In this mountain relatively rich patches of mineral have been mined for export to England for many years past. Alunite is important because it contains potash and alumina in a readily accessible form. It may be described as a basic sulphate of alumina and potash. A perfectly pure specimen should contain 11 per cent. of potash, and 37 per cent. of alumina. Alunite from Carrickalinga, South Australia, contains slightly more than 10 per cent. of potash, and nearly 36 per cent. of alumina. The composition of the mineral mined at Bullahdelah, New South Wales, varies somewhat, but the better grades average 8 per cent. of potash, and 35 per cent. of alumina.

Both potash and alumina play important parts in modern chemical industry. Potash compounds are used largely as fertilizers, and also in manufacturing processes. The present price of commercial sulphate of potash on the London market is £65 per ton, having since the outbreak of war steadily risen from £10 a ton in consequence of the failure of German supplies. Alumina is used for making special furnace linings; it also forms the raw material from which the metal aluminium is manufactured. Alumina also forms a convenient starting-point for the preparation of aluminium salts, alums, and the like, which are extensively used in the tanning and dyeing industries. Hitherto no source of potash or alumina so readily accessible as alunite has been discovered in Australia.

Mr. F. W. Janes was appointed, with a salary, to devote his whole time to experimental work under the direction of a Special Committee. The work of the Committee, since its appointment, has gone on continuously, and much valuable information is now available to manufacturers and others. The experimental work is being carried out in the metallurgical laboratories of the University of Melbourne, representative bulk samples having been obtained from each of the important fields; and the Committee was able to conduct not only laboratory tests but technical experiments upon parcels of 56 lbs., and upwards, of the mineral at a time. A progress report of work done during last year was presented to the Executive Committee in January last; a further report on the results of more recent work is in course of preparation.

It was found that a comparatively simple process, *i.e.*, that of heating alunite to bright redness for a short period, is the most satisfactory method of treating the mineral. A full investigation has been made as to the exact conditions necessary to secure good results, and the results are dealt with in detail in the Committee's reports. A furnace of the reverberatory type is required. The calcined material contains nearly 30 per cent. of sulphate of potash, and about 60 per cent. of alumina, and may be employed as a potash fertilizer without further treatment. In this case, however, no use would be made of the alumina. By treatment of the calcined material with hot water, the potassium sulphate is dissolved, and may be separated from the alumina, which remains undissolved. The solution, when evaporated without further treatment, yields potassium sulphate of the usual commercial grade. The Committee was fortunate in obtaining evidence as to the methods now employed in America for working alunite, which has recently received much attention there.

The Committee has reached a stage when it can definitely state that no serious technical difficulties stand in the way of any one desirous of producing sulphate of potash and alumina from Australian alunite, and the Committee, having regard to the nature of the operations involved from the mining of the alunite to the marketing of the product, is of opinion that the manufacture of sulphate of potash could be carried on with profit if done on a sufficiently large scale by means of modern appliances, always provided that a local market for the output of the plant could be obtained; in other words, the difficulties, if any, in the way of developing the alunite industry are now economic rather than technical.

3. Other Chemicals.—The production of a number of other chemicals in Australia has been considered by the Executive and the Chemical Committee. Amongst these may be mentioned lanoline, cream of tartar, copper sulphate, casein, pepsin, rennet, and other by-products of the meat industry, starch, glucose, and industrial alcohol. The latter is dealt with in connexion with alcohol engines in the section on Engineering (pages 41 and 42.)

Lanoline is a substance closely related in composition to the waxes. In admixture with various fatty bodies it constitutes the yolk of wool. In Australia there is as yet no recovery of this and the other valuable by-products of wool scouring. In England it has been the custom to add acid to waste scour liquids in order to recover the wool-grease. Such treatment results in the formation of an inferior product containing, in addition to the lanoline, the fatty acids of the wool, and of any soap used in the washing process. To recover pure lanoline from the scour liquors it is necessary to use other methods of treatment. The purified product is used in making up pharmaceutical preparations, and large quantities are absorbed by the soap-making industry. Information regarding certain new processes has been brought before the Chemical Committee, which has also interviewed representatives of the wool and wool-scouring industries on the subject. Hitherto only a very small proportion of the wool exported from Australia has been scoured before shipment, but it is thought that in the future a much greater proportion will be treated here. The Committee has, therefore, taken steps to bring together possible users and producers of lanoline, and are making available to the latter all the information in their possession on the treatment of the scour liquors.

During the year 1914-15 the value of the cream of tartar and tartaric acid imported into Australia was over a quarter million sterling. These materials, which are used almost exclusively in the manufacture of baking powders and self-raising flours, are by-products of the wine industry. On making inquiries it was found that only a very small proportion of the crude cream of tartar was recovered in the wine-producing States of Australia—that is, South Australia, Victoria, and New South Wales. Although the estimated production of cream of tartar in Australia, if recovered, would not equal the amount imported, it seemed desirable to take steps to make use of this by-product. Accordingly, the Chemical Committee recommended that co-ordinating committees be appointed in each of the wine-producing States for the purpose of investigating the matter. These committees have been appointed, and the work is proceeding.

The Chemical Committee is able to report that the production of copper sulphate is now being carried on on a considerable scale; also that extensive establishments for the manufacture of electrolytic zinc and calcium carbide respectively are under construction in Tasmania. That the production of white lead in Australia is not equal to the demand does not appear to the Committee to be a very satisfactory state of affairs in a lead-exporting country. The Committee has been informed that a factory capable of producing 5,000 tons of white lead per annum will be in operation before the end of this year.

The question of the production of casein was investigated by the Executive Committee, and the evidence obtained showed that the small local demand was already met. Figures placed before the Committee showed that in normal conditions the largest gross return was obtained from milk by using it for the manufacture of cheese, the smallest by producing butter and casein, an intermediate return being given by butter factories which only take cream from the farmer and leave him the skim milk for raising stock. Under these circumstances the manufacture of casein, beyond that required to satisfy local demands, is not likely to be undertaken permanently in Australia, though under present war conditions it would probably be more profitable than cheese-making.

Owing to the prohibition of the export of rennet from England as a war regulation, the price of this substance in Australia rose enormously, and cheese-makers were unable for a time to secure at any price as much as they desired. The question of the local manufacture of rennet was, therefore, investigated by the Committee and information obtained from various sources. Largely as a result of this information, which was distributed to firms interested in the meat industry, at least one firm has undertaken the manufacture of rennet on a commercial scale. At the same time it was pointed out to cheese-makers that pepsin is almost, if not quite, as useful as rennet in the process. (Many physiologists regard the ferments rennin and pepsin as identical.) Experiments were undertaken by the Agricultural Department of Victoria to investigate the matter,

and some excellent samples of cheese were produced with pepsin. It was urged further that the local manufacture of pepsin was more worthy of encouragement than that of rennet, since, apart from its use in cheese-making, it could be utilized in the manufacture of peptonized foods. The production of various other by-products of the meat industry, including glue, gelatine, tallow, and medical extracts, was also fully considered by the Executive. The conclusion was reached that most of the waste of these substances which was alleged to occur in meat-works was due to the economic conditions under which such works are conducted in Australia, rather than to lack of knowledge of the value of the products wasted. In many cases, moreover, the market for special products in Australia is too small to make manufacture remunerative.

The question of the local production of glucose was also investigated by the Committee, in view of the large quantities of this substance imported from the United States. Inquiry, however, showed that a factory for the production of starch and glucose from maize had recently been established in Victoria, so no further action was taken.

G.—OTHER SECONDARY INDUSTRIES.

1. Leather and Tanning.—The leather industry is one of the most important secondary industries in Australia, yet it seems probable that it will become even more important when tanning is placed on a more scientific basis. The Executive Committee were strongly impressed with this fact as the result of a report prepared by a Sub-Committee of the New South Wales State Committee which visited several tanneries in Sydney. It was found among other things that no attempt was made at these tanneries to determine the amount of tannin, or even of extract, in the tan liquors prepared, and no analyses were made of the original bark nor of the spent bark. The proportion of bark and water used was not weighed or measured, and the water was in some cases used cold, in others hot, whilst in the latter the exact temperature was not determined. The tanners rely on the appearance and taste of the liquid, with the result that a great deal of time and material is often wasted before the required liquor is obtained.

It is true that in some few tanneries in Australia chemists are employed to analyze the barks, and, to some extent, to control the tanning process, but in the great majority conditions are as above described. The tanners interviewed admitted that their methods left much to be desired, and that they would welcome any scientifically worked-out method of procedure which would enable them to obtain extracts of definite and uniform strength.

The Executive decided, therefore, to appoint a Special Committee to investigate processes of extraction of tannin from wattle-bark with a view to the determination of a standard and scientific method of procedure under practical conditions. This Committee has commenced operations at the Sydney Technical College. It had been hoped by the Executive that the tanners would be willing to assist this inquiry by the provision of a portion of the necessary funds. The New South Wales Master Tanners Association was approached, and, while in sympathy with the aims and object of the investigation, expressed the view that all the tanners in Australia should be asked to contribute. It was thought that negotiations with the tanners in all the States would take too long, and the investigation has, therefore, been begun without waiting for financial assistance from the industry.

Australia's increasing dependence on South Africa for wattle-bark has been referred to above (p. 26), and the inquiry just mentioned should help to reduce the imports of the bark by leading to its more economical utilization. The Special Committees appointed in Queensland and Western Australia to investigate mangrove and red-gum bark respectively, and find means, if possible, for removing the disabilities under which these materials suffer have already been referred to when discussing Forest Products (p. 27). These three Committees dealing with allied subjects are in communication with one another, so that all possibility of unnecessary duplication of work is removed. Other inquiries undertaken by the Committee which have a close bearing on the leather industry are the subjects of tick eradication and the branding of cattle. These matters have been discussed when dealing with the pastoral industry (pp. 16 and 24).

2. Food Supply.—The Committee has directed attention to questions connected with meat, milk, and bread. Regarding the former, it was alleged by the Victorian Branch of the Meat Industry Employees' Union that the meat-works in

Australia were conducted on a wasteful system, whereby a large amount of good food, such as sheep's heads and fries, was boiled down for fertilizers. On inquiry the Committee learnt that the managers of most of the meat-works were anxious to utilize these portions of carcasses if possible, but that the local demand was very small, and it did not pay to export them owing to the small prices realized in proportion to the bulk.

In regard to milk, the Committee received an application from Dr. J. B. Cleland and Mr. W. H. Myers, of Sydney, for assistance in their research on the electrical sterilization of milk. Work already carried out at Liverpool, England, has proved that electrical sterilization of milk may be conducted on a large scale, and that it has certain advantages over any other system. No complete scientific investigation of the process has yet been made, however, and the exact means by which the electric current destroys the bacteria in the milk is not known. Further, the best and most economical conditions of working have not been ascertained. A recommendation for a grant of £100 for the purchase of apparatus and other expenses connected with this research was approved, and, as far as their other duties have allowed, the Special Committee have pressed on with the experiments (see paragraph (i) below).

A research which may have an important bearing on the solution of the day-baking trouble is being conducted at the Sydney Technical College by Dr. H. G. Chapman, under a grant from the Executive. The investigations are being carried out primarily with the object of discovering "races" of yeasts which will produce more rapid ripening of doughs in the manufacture of bread, and already Dr. Chapman has succeeded in reducing the time of the dough in the trough from eight to five hours. This has been done by improving the fermenting power of the yeast, and not by increasing the quantity used. The ability to ferment at any particular rate does not appear now to be a property of the cells of each "race" of yeast, but can be changed readily by suitable culture through successive generations. Dr. Chapman expects to diminish still further the time of ripening, and is now experimenting with four-hour doughs (see paragraph (ii) below).

(i) *Electrical Sterilization of Milk.*—The milk supplies of the large centres of population in Australia are of great importance both from the public health and the economic aspects. An abundant supply of pure, sound, fresh milk is essential for the successful up-bringing of children, and is of great importance as one of the principal food supplies of the adult population. In all large cities the milk supply must be derived in greater or less amount from some distance from such centres of population. In cold climates the transit of milk over long distances does not lead to such rapid deterioration in quality as occurs in warm climates when the germs can increase with greater rapidity. Already the milk supplies of Australian cities have to be derived in most instances from a very considerable distance. Whilst in cold winter weather such transit leads to little deterioration, in summer time changes rapidly occur, so that a considerable amount of milk may be lost to consumption in consequence, and the balance be decidedly deteriorated. If means can be devised for insuring a decided lessening of these bacterial changes during transit, not only will the supply of food to the public be improved, but the economic loss to the producer will be lessened; whilst if the distance from which the milk can be successfully brought is increased, a wider field of supply will follow with an increase in size of the industry. At present the chief means of retarding bacterial changes in milk during transit—when any attempt at all is made—is by reducing the temperature of the milk to one at or little above 40° F. In many instances no special attempt is made to prevent bacterial growth during transit, but the milk on arrival is subjected to a form, more or less imperfect, of pasteurization.

The experiments of Dr. Beattie and F. C. Lewis at Liverpool, on the electrical sterilization of milk by means of alternating currents, called the attention of the Committee to the value such a process might present if it could be practically and economically applied to Australian conditions. The Liverpool investigators have applied the principle commercially on a small scale for certain purposes. Can the method be applied to Australian conditions at a reasonable cost? It seemed to the Committee that the importance of the matter well warranted a thorough investigation. In the first case the Committee set themselves to endeavour to ascertain on what principle the sterilization of the milk depended. Before a practical commercial scheme could be presented it seemed essential that this point should be determined. The Committee were of opinion that the sterilization probably depended on one or other, or more than one, of the following factors:—

- (a) That it might be due to transitory heating of the milk.
- (b) That it might be due to electrical shock—whatever such shock may be considered to be as applicable to living bacteria.
- (c) That it might be due to chemical changes brought about by electrolytic means, the chemical bodies perhaps produced temporarily combining with and destroying the bacteria.

As a side issue to the first of these, *i.e.*, sterilization by heat, it occurred to the Committee that it might be of value to investigate the effect on milk of keeping it for lengthy periods of time at a temperature some degrees above that at which the bacteria which usually gain entrance can multiply. It seemed that it might be practicable in a hot climate like that of Australia to convey milk from the producer to the cities at a temperature sufficiently above that at which the organisms in the milk can multiply, and yet not sufficiently high to cause chemical changes in the milk, or perhaps to destroy the ferments contained in it. It seemed, therefore, that it might perhaps be cheaper to thus convey milk at a slightly raised temperature, at any rate in hot weather, rather than at a decidedly reduced temperature. The committee in consequence undertook some preliminary experiments, which consisted of maintaining at a temperature of 50° to 55° C.

for a period of several days some ordinary domestic milk as delivered by the dairyman. Unfortunately these experiments in this particular instance have shown that even at a temperature maintained at this height, certain thermophilic spore-bearing organisms not only survived, but multiplied. These organisms which gained access to the milk were probably derived from cow-dung. The changes they produced in the milk were slight and progressed slowly, but the presence of a number of organisms was revealed on culture. As far as the Committee have therefore gone at present, it seems doubtful whether milk, unless obtained with much greater care than is usually bestowed upon it, can be kept in an unchanged state, from a bacterial point of view, for a period of several days at a temperature of from 50° to 55° C. This matter requires further investigation, as it may well be that though milk cannot be thus well preserved for a few days the principle may nevertheless be applicable for the transit of milk when the period is measured in hours.

The Committee have also carried out a preliminary experiment in which they passed an alternating current through agar jelly seeded with coliform organisms, from the point of view of endeavouring to ascertain whether the sterilization which results in the passage of such current is due to electrolytic dissociation in the neighbourhood of the electrodes. In the preliminary experiments thus far carried out no evidence of such sterilization due to electrolysis is apparent, the growth of the organisms being apparently as abundant in the immediate proximity of the electrodes as at a distance from them, which should not be the case if the setting free of ions in the neighbourhood of the electrodes leads to sterilization in this position.

The Committee is engaged in further experiments on the principles governing the electrical sterilization of milk by an alternating current from the point of view of ascertaining the electrical variations leading to the best and most economical results. Through the kindness of Assistant Professor Madsen, of the Sydney University, they have been lent a motor generator by means of which these experiments are being conducted.

(ii) *Yeasts for Bread-making.—Report of Special Committee.*—Study has so far been confined to the growth in a malt wort of yeast leading to rapid ripening of dough. The yeast has been tested by its activity in doughs which have been made into bread at the School of Bakery, Technical College, Sydney. The doughs have been prepared with 270 lbs. flour, including the weight of flour used on the table, and 160 lbs. water. The average yield of bread has been 175 loaves, weighing, approximately, 355 lbs. The doughs have usually stood six hours in the trough, at a temperature of 83° F. For some time doughs standing five hours in the trough were used.

The quantity of yeast has been determined by counting the number of yeast cells in a given amount of wort. The weight of yeast obtained from a wort containing a given number of yeast cells has been ascertained. The weight of yeast used in the doughs has varied from 2½ to 5 ounces. The acidity of the worts has been usually less than 10 c.cm. N/10 acid in 100 c.cm. wort, when estimated by titration with methyl-orange as indicator. As the bread has been made regularly under commercial conditions, bread has sometimes been made with worts of higher acidity. In the preparation of yeast it has been found that the temperature of the wort during the growth of the yeast should be less than the temperature at which the dough stands. Abundant oxygenation favours the development of yeast fermenting rapidly. The presence of flour in the wort prevents any check to fermentation when the yeast is mixed in the dough. The worts have contained about 15 per cent. solid matter, of which one-half consists of reducing sugars. In the bake-house, the wort is made with a decoction of hops, to which flour and ground malt are added. This mixture stands at 155° F., until the whole of the starch disappears. The mash is strained from the liquor. The wort is boiled and cooled rapidly. It is placed in a large flat enamel pan, which has been sterilized by boiling water in it for some time. The wort is beaten with a whisk to aerate the liquid, and is inoculated by the addition of a considerable amount of stock from the previous brew. The yeast grows for sixteen hours. The multiplication of yeast cells in this time is about ten times, but varies greatly.

Much assistance has been rendered by Miss M. M. Lilley at the University, and by Mr. F. A. Elliott, the baker at the Technical College, who has spared no trouble to insure uniformity in testing the yeasts in the manufacture of bread.

3. Pottery.—Certain "communications relating" to the clay industries were referred to the Chemicals Committee by the Executive. Personal interviews arranged with representatives of the principal pottery "companies" and others have shown that—

- (a) Australia possesses an abundance of clay and kaolin suitable for the manufacture of bricks, tiles, stoneware, and various grades of porcelain ware, but that deposits of "ball" clay—the white burning, highly plastic clay—are rare. A certain proportion of "ball" clay is required in porcelain work, and it has been found necessary to import this from England.
- (b) In the manufacture of certain grades of stoneware, Australian potteries are not behind other countries, and stoneware pipes have been exported in large quantities to eastern countries, notably the Philippines. Recently, however, the exports have ceased through high rates of freight and increased cost of labour.
- (c) That in regard to the better grades of clay products the industries here are in a very backward state.
- (d) That the backward state of the industry is due, not so much to the lack of skilled clay workers, as to the need of trained technologists capable of directing operations and of scientifically blending the various clays necessary to produce the required properties in the finished product.

- (e) That any attempts to assist the industry by encouraging the establishment of schools of potteries and ceramic research laboratories would receive the support of the companies communicated with.
- (f) That it is desirable to make a systematic examination of Australian clays, and search especially for "ball" clays. The Committee is strongly of opinion that active measures should be taken—
 - (1) To collect and co-ordinate the data on clays published by the various State Geological Departments, and to continue the work they have begun;
 - (2) to encourage the establishment of schools of pottery;
 - (3) to assist competent research chemists and physicists in carrying on ceramic investigations;
 - (4) to induce manufacturers to produce the higher grades of porcelain ware, including domestic porcelain.

An allied question to which the attention of the Executive Committee has been drawn is the unsatisfactory nature of the enamels, glazes, and pottery colours used in Australia. The matter was referred to the Chemical Committee, which has reported that research into the chemical and physical properties of these materials is highly desirable, and the Executive are endeavouring to arrange for such investigations to be begun.

4. Paper-making.—Australia is at present almost entirely dependent on the outside world for its supplies of paper-making materials. In view of the present shortage of shipping, together with the increasing scarcity of such materials throughout the world, the whole question of paper-making in Australia obviously merits careful consideration. The Executive have received many suggestions as to possible paper-making materials. The question of the local production of wood-pulp has been discussed earlier in this report (p. 25), but, in addition, the Committee have considered the possibility of utilizing wheat-straw, marram-grass, and lalang or blady-grass. The prospects of establishing a paper-making industry in South Australia are discussed in a Bulletin published by the South Australian Department of Chemistry,* in which the conclusion is reached that wheat-straw is the most promising material in that State. The following materials are discussed in an Appendix to that Bulletin, viz.:—Inner trunk and leaves of grass-tree, posidonia fibre, stinkwort, marram-grass, and a native grass—*Lepidosperma gladiatum*. Other materials which have been suggested are stalks of maize, and of broom-corn, flax-straw, sugar-cane refuse, old cotton-plants, banana-tops, lantana, prickly-pear, St. John's-wort, bracken-fern, hybiscus, *Sida retusa*, and *Ecdeiocolea monostachya*. Preliminary tests of a number of these materials have given promising results, but the main difficulty would probably be to obtain a sufficient supply of any of these, except wheat-straw, to enable them to be successfully utilized on a commercial scale. Weeds such as prickly-pear, St. John's-wort, bracken-fern, and lantana, of which large quantities are available, do not appear very promising as sources of paper-pulp, though it is possible that their utilization for this purpose may help to pay the expenses of their eradication. From articles in the press it appears that blady-grass, and various weeds, are being utilized for paper-making by a company which has recently started operations at Cairns, Queensland. Tests of different materials for this purpose should form a valuable portion of the work of the botanical section of the permanent Institute, and it will probably be necessary to erect a special plant for the purpose similar to those already established in Germany, England, Canada, and the United States.

(i) *Marram-grass*.—This grass (*Ammophila arundinacea*) has been used in many parts of the world for planting on sand-dunes in coastal areas, to check the drift of the sand, and for this purpose is universally acknowledged to be the most useful plant in temperate climates. It has been planted to some extent in all the Australian States, except Queensland, and it is estimated that at the present time about 5,700 acres of coastal lands in Australia are planted with marram-grass, 4,500 of which are in Victoria, where the chief plantations are in the neighbourhood of Port Fairy. Experiments carried out in England by Messrs. Clayton Beadle and Stevens† led them to conclude that though the fibres are shorter than those of esparto-grass, the paper produced from it was of greater strength, and was suitable for fine printings, and it is understood that as a result of their tests marram-grass is now being utilized by English paper-making firms. Tests made in Australia by the South Australian Department of Chemistry and by the Australian Paper Mills, Melbourne, appear to show that the qualities of the grass grown at Port Fairy are similar to those of that grown in England. The Australian Paper Mills report, however, that the grass suffers from the

* South Australian Department of Chemistry, Bulletin 1, Adelaide, 1916.
 † Kew Bulletin, 1913, No. 9, p. 363.

disadvantages that (1) knots are left after the boiling process, and (2) it is impossible to remove entirely the considerable proportion of sand and shell grit present, so that the resulting paper is dirty. It is doubtful also whether under Australian conditions the harvesting of marram-grass could be effected sufficiently cheaply to make it a commercial success. Further inquiries are being made by the Committee.

5. Textiles.—The dependence of Australia on the outside world for textile fabrics of all kinds is well known. At the present time the only fibre produced in the Commonwealth to any considerable extent is wool, and of this only about 2 per cent. is at present used locally. Cotton and linen goods are not manufactured in the Commonwealth, and it is not probable that these manufactures will be developed locally until the raw materials are produced in Australia. Steps taken by the Executive to assist the growing of cotton and flax have already been referred to (*see pp. 21 and 22*). A fibrous material of which a large supply is available locally, but for which the best treatment and usages do not appear to have been yet discovered, is the marine-fibre derived from *Posidonia australis*. A Special Committee was, therefore, appointed by the Executive to investigate the physical and chemical properties of this fibre, with a view to determining the purposes for which it is most suitable.

(i) *Posidonia*.—The fibrous portion of the leaf-sheath of this marine plant has on certain sheltered parts of the Australian coastline formed considerable deposits in shallow water. Up to the present, the chief deposits that are known are those in Spencer's and St. Vincent's Gulfs, South Australia, but it seems possible that others may be found in Western Australia, where the plant is abundant.

Three large companies have between them spent £220,000 on machinery for raising, cleaning, and drying the fibre, and as a result of numerous experiments, they have solved most of the difficulties, and have proved that the material can be raised and cleaned at commercially remunerative prices. Full information as to the processes adopted is contained in a Bulletin on Marine Fibre, by D. C. Winterbottom, published by the South Australian Department of Chemistry.* A quantity of the material has been disposed of in Australia for insulating steam and refrigerating plants, house cooling, and the manufacture of bedding, and for these purposes it has proved very satisfactory. The amount required for these purposes, however, is not large enough to allow of the free growth of the industry, which, to be successful, can only be worked with a large output.

The chief uses which have been suggested as likely to lead to a greater demand are for textile purposes, as a substitute for cotton in the manufacture of nitro-cellulose, and as a material for paper-making. As a textile, *posidonia* fibre suffers from various disadvantages as compared with jute, to which it is most similar, but it has several properties not possessed by other vegetable fibres which ought to give it special advantages for certain purposes. Its strength is not great and is variable, and it is brittle. It has been stated that this brittleness can be overcome by special treatment, and this is one of the questions which the Special Committee is investigating. The brittleness of the fibre leads to an excessive amount of waste when the fibre is carded in the ordinary way, but it is possible that a special process might be evolved to avoid this. On the other hand, the fibre has almost no elasticity, so that material made from it will not stretch, and it is unique amongst vegetable fibres in the readiness with which it can be dyed. The chemical investigations being made by the Special Committee may throw light on the reason for this property. Owing to its non-conducting and dyeing properties, it is suitable for mixing with wools for the production of low-grade materials. It is also extremely resistant to rot, and not affected by damp or heat. This property may lead to its utilization in place of jute for bags, but special machinery would be necessary for this purpose, the ordinary machinery for jute bag-making not being suitable.

As a source of cellulose in the manufacture of cordite, *posidonia* fibre is unlikely ever to compete with cotton, at any rate for military purposes, since it is important that the service propellant used throughout the Empire should be uniform, and *posidonia* not being a cultivated crop the supply, though large, is not inexhaustible.

As a material for paper-making, *posidonia* is fairly promising, but it seems unlikely that it will be able to compete with other materials for this purpose, as it could not be raised, washed, and delivered at a cheap enough rate. Boiling the fibre with caustic soda produces little effect upon it, but it responds readily to a treatment with chlorine, and this might be effected while it is still damp with sea-water, by submitting it to electrolysis.

6. Engineering.—In the engineering industry the Committee have given attention to three main problems. These are—(i) The process of manufacture of solid-drawn cylinders for holding compressed gases; (ii) the possibility of developing the ship-building industry in Australia; and (iii) the design and manufacture of internal combustion engines suitable for using alcohol as a fuel, in place of mineral oils.

In recent years a considerable number of cylinders have been imported into Australia for holding compressed gases, such as anhydrous ammonia, oxygen, and carbon-dioxide. With the extension in the use of refrigerating machinery, and with modern developments in the production of oxygen from the atmosphere and in the industrial uses of that gas, the demand for such cylinders is rapidly increasing. Owing to the high pressures to which the cylinders are subjected, special materials and special processes have to be used in their manufacture. In view of the difficulty in obtaining

* South Australian Department of Chemistry, Bulletin 4, Adelaide, 1917.

cylinders from abroad, and of the necessity for maintaining a supply of the cylinders for the distribution of the gases upon which various industries are dependent, the question of manufacturing the cylinders in Australia is of considerable importance. The Committee have already obtained certain information, regarding the technical processes of manufacture of the cylinders, and are expecting to receive from England at an early date complete details which will enable the manufacture of the cylinders to be undertaken in this country, if it is found that economic conditions are suited to the establishment of the industry.

In March, 1917, Captain J. H. Butters and Mr. H. W. Gepp, members of the Tasmanian State Committee, directed the attention of the Executive to the importance of immediate steps being taken in this country to develop the ship-building industry on a standardized basis. After making inquiries and consulting experts on the matter, the Executive formed the opinion that the first step necessary with a view to giving effect to the proposal was to obtain a report on the whole question, setting out the possibilities and the difficulties that would have to be overcome, especially in regard to the supply of materials and skilled labour, the size and type of vessels that should be built, the rate at which they could be constructed, equipped, and manned, and the purposes for which they could be used. The Executive proposed to appoint a Special Committee of experts to enquire into and report immediately upon the whole matter, and they recommended that a grant of £500 should be made for the expenses of the proposed committee, and for the payment of fees to such experts as the Committee might find it necessary to employ. As the Executive did not receive the necessary approval for the grant, and as the whole question was a month later taken in hand by other authorities, no further action has been taken by the Committee.

The question of the utilization of alcohol as a fuel for internal combustion engines has attracted a considerable amount of attention in various countries in recent years. This is largely due to the prospective shortage in supplies of mineral oils. Increased attention has recently been drawn to the question in view of the rapid rise in the price of these products, and of the large quantities of alcohol required for munition purposes. In Australia petrol has increased in price from 1s. per gallon in 1908 to 2s. 7d. per gallon in 1917. If the war continues there is a prospect of a serious shortage in the supply of petrol in Australia, if not even of a complete cutting off of the supply. As there are no payable oil fields in Australia the question is one of considerable importance and urgency. In any case, even if the war ends soon, the supplies of mineral oil are practically stationary, while the world's demand for that commodity is increasing enormously. In March, 1917, the Executive appointed a Special Committee to investigate the subject, and a sum of £250 was provided for the expenses of the Committee up to the 30th June, 1917. In the first progress report of the Special Committee it is stated that the main aspects of the problem requiring consideration are as follow, viz. :—

- (a) The design and manufacture of the engine.
- (b) The supply of the alcohol, including its distribution.
- (c) The denaturation of the alcohol.

The Special Committee are of the opinion that it is desirable to pursue their investigations into each of the above aspects of the problem concurrently, since it is obviously useless to produce an efficient engine if a proper supply of suitable denatured spirit is not available, while, on the other hand, the supply of spirit will not be forthcoming in any considerable quantity until manufacturers are prepared to place their engines on the market.

Though the questions of the supply and distribution of alcohol and its denaturation are not, of course, engineering problems, it is convenient to refer to them in this part of this Report, as they are being dealt with by the same Committee as is investigating the question of the design and manufacture of alcohol engines.

(i) *The Design and Manufacture of Alcohol Engines.*—A large amount of work in the design and manufacture of alcohol engines has already been carried out, especially in England, France, Germany, and America, and alcohol has been used for a number of years with success in specially designed engines, particularly in Germany. Any petrol engine of the ordinary types can be run on alcohol without material change in its construction. The main difficulties encountered are in starting and in supplying a sufficient quantity of fuel. When alcohol is used in an ordinary petrol engine the consumption of fuel per b.h.p. is about 50 per cent. greater than in the case of petrol. It appears, however, that the consumption of alcohol per b.h.p. in a specially designed alcohol engine will not exceed in volume the consumption of petrol in a petrol engine.

The main alterations necessary in the ordinary design of petrol engines to fit them to work efficiently on alcohol are as follow, viz. :—(a) An increased compression from about 75 lbs. per square inch, which is the average for petrol engines, to about 180 lbs. per square inch, both above atmospheric pressure; (b) a preheating of either the fuel or the air or of the mixture of fuel and air; (c) an increase in the area of the fuel jets and fuel supply pipes.

Though an alcohol engine designed in the above manner will run efficiently, it cannot generally be started from cold with alcohol. In order to overcome this difficulty some special means must be provided. For example, either the carburetter must be preheated by a torch or in some other way, or an arrangement must be provided whereby a small amount of petrol can be used at the start. When a temperature sufficient to vaporize the fuel is attained, the alcohol can be gradually turned into the carburetter and the preheating of the fuel maintained by the exhaust gases. Alcohol possesses various advantages over petrol as a fuel. In the first place, the products of combustion in an alcohol engine are practically odourless and are free from smoke. Secondly, the risk from fire in the storage and handling of alcohol is much less than in the case of petrol. Thirdly, there are many theoretical, chemical, and physical reasons why alcohol should yield superior results. It can be used without danger of pre-ignition under high compression; it can yield a much higher percentage of its available heat contents in the form of work; and for carburetting purposes it is stated to be much more homogeneous than other fuels with which it competes. Lastly, alcohol is produced in Australia, and, if necessary, can be manufactured in largely increased quantities in this country.

For reasons indicated in their Report, the Special Committee have decided to devote attention primarily to the design and manufacture of stationary engines which have a low piston speed and long stroke, rather than to the motor-car engines, which have a high piston velocity and comparatively short piston travel. The Committee are working in co-operation with the Imperial Motor Transport Council, London, and the secretary of that Council is making inquiries on behalf of the Committee as to the most efficient type of engines available. On receipt of the desired information the Committee proposes either to purchase or to have constructed an engine or engines for demonstration purposes. It is considered that much can be accomplished in the way of advertisement and of familiarizing people to the use of alcohol as a fuel by exhibiting alcohol engines at work at agricultural shows and other exhibitions in the Commonwealth. It is hoped in this way to induce manufacturers in Australia to turn their attention to the production of alcohol engines. The Committee are already in touch with several engineering firms in Australia which intend to carry out experimental work with alcohol as a fuel.

(ii) *The Supply of Alcohol.*—The supply of alcohol is likely to prove a much more difficult problem than the question of the design of the engines. The most economical source at the present time for the production of alcohol is from sugar molasses, but even if the whole available supply of molasses in Australia were used for the purpose in view, it would be sufficient for the production of only about 4,000,000 gallons of alcohol per annum, whereas the annual importations of mineral oils are in the neighbourhood of 17,000,000 gallons. The total average annual quantity of molasses available in Australia for distillation is about 50,000 tons, of which about 12,500 tons are now used for that purpose. The remaining 37,500 tons are largely wasted. The present price of methyl alcohol produced from molasses is about 1s. 9d. per gallon, *ex store* in Melbourne.

It appears unlikely that any considerable quantity of alcohol can be manufactured in Australia from either raw or waste materials not at present utilized. The most important of these materials are waste timber, grass-tree, prickly pear, waste fruit, and straw. The production of alcohol from cellulose, such as waste timber or straw, is costly, and the immediate prospects of producing alcohol from these sources on a profitable basis do not appear encouraging. The whole question is receiving consideration.

If the required supply of alcohol cannot be produced from raw or waste materials not at present utilized, it will be necessary to grow special materials for the purpose. The most promising sources in this respect appear to be maize, wheat, barley, potatoes, and beet. The Committee have obtained information on these matters from various distillers and other persons, and are making further inquiries.

Various authorities have proposed that alcohol should be used as a fuel in admixture with other materials, such as benzine, ether, or acetylene. The advantages claimed for the use of such a mixture are set out in the Report of the Special Committee, who consider, however, that, broadly speaking, the arguments in favour of the use of a mixture apply to motor-car engines rather than to stationary engines. The Committee are of the opinion that in view of the higher thermo-dynamic efficiency of alcohol, it is desirable to aim primarily at the adoption of engines using that commodity alone as a fuel. Concurrently with the development of stationary alcohol engines, the Committee propose to take steps with a view to bringing alcohol, either as an admixture or alone, into use for motor-car work.

(iii) *The Denaturation Problem.*—The denaturants at present necessary for industrial methylated spirits under the Excise Act and Regulations are as follow, viz. :—2 per cent. of wood naphtha, $\frac{1}{2}$ per cent. each of pyridine and mineral benzine. The cost of these denaturants is 1·74 pence per gallon of alcohol. In order that power alcohol may be available at as low a price as practicable, it is desirable that an alteration should be made in the existing regulations as to denaturation. The Committee are in communication with the Comptroller-General of the Department of Trade and Customs on the matter, and have asked if the addition of 1 per cent. of pyridine only would be satisfactory. This would reduce the cost of denaturants to 0·9 pence per gallon of alcohol. The suggestion was not acceptable to the Customs authorities, who have, however, granted permission for the Committee to obtain a supply of a quarter-cask (32½ gallons) of spirit for experimental purposes denatured in the manner suggested. The Committee are making inquiries, and are collecting data, with a view to determining upon a cheap and efficient denaturant which can be produced in Australia. In this matter particularly the Committee are co-operating with the Imperial Motor Transport Council, London, with a view to obtaining a denaturant which will be generally acceptable throughout the Empire. The Committee hope that the whole excise question will be dealt with by the authorities in a liberal spirit. Otherwise artificial difficulties in the way of the extended use of industrial alcohol will be greatly increased.

7. Miscellaneous.—The Executive have received several inquiries from manufacturers asking for information as to processes. Of these may be mentioned the production of sal ammoniac, the distillation of oil and other coal-products, the commercial treatment of feathers and of pith cane. Unfortunately, in neither of the latter cases has it been found possible to give the desired information, though it is probable that if the permanent Institute had been in existence, this could have been obtained by experimental work in its laboratories.

(i) *Treatment of Feathers.*—Previous to the war, feathers were shipped in large quantities from Australia to Germany, where they were treated by special processes and machinery before being utilized for filling cushions, mattresses, &c. When the export to Germany was stopped by the war, several Australian firms made attempts to utilize feathers in this country, and one of these approached the Committee for information as to the best means of sterilizing feathers without rendering them more brittle, and less soft, these results being found to take place with ordinary treatment. As no information appeared to be available in Australia, and the Committee understood that feathers were largely treated in Norway, inquiries were kindly made from that country by the Norwegian Consul in Melbourne. The reply received was that Norwegian feathers were also mainly treated in Germany, or by German machines. The Committee has since learnt that the firm in question is now placing feather goods on the market.

(ii) *Treatment of Pith Cane.*—The so-called pith cane used in the manufacture of chairs, go-carts, &c., is a product of the East Indies. In its untreated state it is inferior, both in colour and elasticity, to bleached cane, which commands a much higher price. The bleaching process was before the war carried out in Germany, and the exact treatment to which the cane was subjected appears to be unknown in Australia, though raw cane is available. Owing to the cutting off of German supplies of bleached cane, owing to the war, manufacturers have had to use other raw materials, such as sea-grass. It seems possible that a laboratory research would indicate a treatment for bleaching and softening the cane.

H.—STANDARDIZATION.

1. General.—In the Report of the Original Drafting Committee is stated that “The highly specialized intricate work of standardizing electrical instruments and other scientific apparatus for use as sub-standards by different Government Departments and other institutions in which research work may be carried on would also naturally fall within the functions of the Institute.” The Executive Committee has accordingly collected information both from published documents and by personal interview with experts regarding the organization and work of standardization institutions in other countries and has considered the probable requirements of Australia in connexion with this class of work. They are of the opinion that work of this nature is not only of fundamental importance to Government Departments and scientific institutions, but would be highly beneficial, firstly, to consumers—in bringing about improvements in quality—and, secondly, to producers—in the adoption of improved standard types and qualities, and of scientific methods of control of temperatures, pressures, measurements of time and space, chemical processes and other technical factors which determine the amount and quality of the output of secondary industries.

The Committee consider that it is of importance that arrangements be made for the following standardizing work to be carried out, viz. :—

- (a) The standardization of scientific apparatus and instruments.
- (b) The testing of electric lamps, apparatus, and machinery.
- (c) The testing of instruments of precision used in industry.
- (d) The physical testing and standardization of materials used in industry and by the Commonwealth Government.

Though it is probable that many of the standards which have been developed in Europe and America can be adopted in the Commonwealth, it will be necessary for investigations to be carried out in order to ascertain whether such standards are suited to Australian conditions. It is also important that some organization shall be established to act as an impartial authority in regard to referee work. The Committee consider that the work of standardization should be developed, so far as practicable, in close touch with industrial associations and other interested parties, as is done in the United States of America through the Bureau of Standards and the American Society for Testing Materials. Though it is obviously beyond the scope of the functions of the Executive Committee to institute any comprehensive scheme of standardization on the lines indicated above, a beginning in this direction has been made in respect of the following matters, viz. :—(i) Standardization of analytical methods in the chemical industries; (ii) standardization of design of scientific apparatus used for

educational purposes ; (iii) the appraisement of alcohol in spirituous liquors ; (iv) the metric system and decimal coinage ; and (v) standardization in the electrical industry.

2. Standardization of Analytical Methods in Chemical Industry.—During the past two years the Society of Chemical Industry of Victoria has, in co-operation with various scientific, industrial, and commercial interests, formulated the details of a scheme for a series of investigations with a view to determining standardized methods of analysis for use in the chemical industries. Other countries, notably the United States of America and Germany, have long since recognised the importance of standardizing analytical methods. Chemists in these countries have done much valuable work in testing methods and selecting those deemed most suitable for general adoption. In some instances methods investigated and recommended in this way are made binding by legal enactment. In Australia analytical methods are playing an increasingly important part in contracts between buyers and sellers of raw materials and manufactured products, for example, in the case of phosphatic rocks for the manufacture of fertilizers, and in the marketing of metallurgical products, such as lead and zinc concentrates and the useful metals. In these cases the detailed methods to be used in valuing the materials are ordinarily embodied in the contract. By the use of standard methods discrepancies between the results of various analyses are reduced to a minimum, and disputes, often involving much loss of time and money, are avoided.

The official methods of the United States Department of Agriculture have, up to the present, been largely employed in the Commonwealth for the analysis of agricultural and other products. But chemists in Australia are reluctant to adopt, without investigation, the methods recommended in other countries, especially in view of the fact that such methods are worked out under conditions and upon materials sometimes differing from those in this country. The scope of the work planned by the Society of Chemical Industry of Victoria in conjunction with other bodies may be summarized as follows, viz. :—

- (a) To review the best methods of analysis of materials.
- (b) To compare the standard methods of other countries.
- (c) To study the results of investigations made with those methods by various workers.
- (d) To conduct comparative tests on proposed methods.
- (e) To recommend methods for general adoption.
- (f) To keep in touch with all current work on analytical methods, and to report on new methods, and on old methods in the light of new research.

The work is to be carried out gratuitously by members of the society. The Executive Committee is of the opinion that not only will the direct results of the proposed investigations be highly beneficial to industry, but that the work will engender among local chemists the habit of scientific research, and will assist in the training and formation of a body of skilled investigators. They have accordingly recommended that a grant of £50 be made to the society for the purchase of materials, and for incidental expenditure connected with the investigations. It is proposed that the grant shall be made on the condition that the society furnishes reports from time to time to the Executive Committee, which will bring the reports under the notice of chemists in other States through the agency of the State Committees of the Advisory Council. In this way it is hoped ultimately to attain uniformity in analytical methods throughout the Commonwealth.

3. Standardization of Design of Scientific Apparatus.—In June, 1916, the attention of the Executive was directed by the Victorian State Committee to the desirability of procuring standard designs for the manufacture of apparatus which is used in the teaching of science, and which could advantageously be made in Australia. The Victorian Committee pointed out that scientific apparatus—especially physical, mechanical, and engineering models—were practically unprocurable from England, and that such apparatus as could be obtained was delivered only after long delay. This is due to the fact that nearly all the British workshops which manufactured scientific apparatus are engaged in war work. It was urged that the drafting of designs for use throughout Australia should be undertaken immediately in order to enable both the teaching of science to be carried on without a shortage of apparatus, and the manufacture of standard apparatus to be undertaken profitably in Australia. It was hoped that

the loss, delay, and inconvenience incidental to the existing methods of obtaining apparatus from abroad by ordering from makers' catalogues would thus be obviated. The proposal was welcomed by the Victorian Department of Education, which was considering the question of taking up the manufacture of scientific apparatus for its own use.

The Executive appointed a Special Committee for the above purposes, and a grant was made for the employment of a draftsman at the salary currently paid (£275 per annum) for similar work by the Commonwealth Government. Applications for the position were invited by advertisement in the press, but the Special Committee decided that none of the applicants who were willing to accept temporary employment possessed the qualifications necessary for the work. The matter is accordingly in abeyance for the present.

4. The Appraisalment of Alcohol in Spirituous Liquors.—The question of altering the present complicated methods for the appraisalment of alcohol in spirituous liquors was brought under the notice of the Executive by the Victorian State Committee. Under the existing system alcoholic liquors are valued in terms of "Proof spirit," which by legal enactment in Australia is spirit of specific gravity 0·9198 at a temperature of 60° Fahr. It is thus possible to have spirit of over 100 per cent. proof strength—a paradoxical and confusing situation. The "Proof spirit" standard is an obstacle in the way of the application of science to industry and could easily be replaced. The Victorian Committee proposed that spirituous liquors should be valued in terms of absolute alcohol by weight, and with a view to achieving that purpose they adopted the following resolutions, viz. :—

- (a) That the existing methods for the appraisalment of alcohol in spirituous liquors be revised.
- (b) That the "Proof spirit" standard be abolished, and valuation in terms of absolute alcohol by weight be substituted.
- (c) That as a necessary preliminary to this reform the Executive Committee be recommended to arrange for the compilation from existing data of—(i) Official alcoholometric tables correlating specific gravities and alcoholic percentages; and (ii) an official formula for the determination of specific gravity at standard temperature from apparent specific gravities at other temperatures.

These resolutions were submitted by the Executive for the opinion and comments of the State Committees in New South Wales, Queensland, South Australia, and Western Australia. The New South Wales, South Australian, and Western Australian Committees approved of them, but the Queensland Committee, though in agreement as to the desirability of a reform, adopted a series of modified resolutions proposing that the proportion of alcohol be recorded in terms of percentage of alcohol by volume and not by weight.

In Victoria and South Australia the opinions of a number of vigneron, spirit distillers, chemists, and wine and spirit merchants, on the desirability of making the proposed change were ascertained. In general, the vigneron, distillers, and chemists are strongly in favour of the change, but merchants and importers, though agreeing in some cases that the change would be desirable, if universally adopted, think that grave disadvantages to the trade would result from the adoption in Australia of a standard different from the English one.

The proposals of the Victorian and Queensland State Committees were communicated by the Executive to the Department of Scientific and Industrial Research, London, with a request for an expression of the views and the advice of the Department on the suggested reform. The Executive was informed that the Advisory Council in England agreed that the existing method of appraisalment was admittedly unscientific, and that the Executive's memorandum had been forwarded to the Reconstruction Committee with a suggestion that it should be referred to Lord Balfour of Burleigh's Committee on Trade Policy after the War.

The Executive are preparing a memorandum on the subject for publication.

5. The Metric System and Decimal Coinage.—The war has shown that if the British Empire is to hold its own in the commercial competition of the future, certain reforms in its business and commercial methods must be made. Prominent among these are questions relating to weights and measures and currency. The defects of the existing systems, and the inconveniences they cause, both in regard to domestic trade and

industry and to international relations, are too well known to require explanation in this Report. In so far as the matter immediately concerns the functions of the Executive Committee and of the proposed permanent institute, it may be pointed out that the introduction of the metric system of weights and measures and of the decimal system of coinage is of importance both in respect to scientific and technical education and in the application of scientific methods to industry. It is believed that the present time, when the public mind is prepared to accept changes that might at ordinary times be unacceptable, may be opportune for the introduction of such systems in the United Kingdom and the Dominions.

The Executive have accordingly taken action in the matter in several directions. In the first place they communicated with the Department of Scientific and Industrial Research, London, asking for an expression of their opinion on the proposal to introduce the desired changes. They were informed that the British Department did not contemplate taking any action in the matter, that the Government Committee on Trade Policy after the war, under the chairmanship of Lord Balfour of Burleigh, would probably take evidence on the subject at an early date, and that the communication received from the Executive had been commended to the careful attention of Lord Balfour of Burleigh's Committee. In the meantime further information has been collected by the Executive from various sources. A comprehensive report on the subject of Decimal and International Coinage has been furnished to the Committee by Mr. F. W. Barford, M.A., A.I.A., of the Commonwealth Bureau of Census and Statistics, while Professor A. D. Ross (Department of Mathematics and Physics, University of Western Australia) undertook to make inquiries on behalf of the Committee during a recent visit to England regarding the present position in that country. The Committee is awaiting the receipt of Professor Ross's Report before taking further action. In conclusion it may be remarked that, consequent upon a Report of a Select Committee, the Commonwealth House of Representatives in 1903 approved of the principle of decimal coinage and the metric system, while it is understood that a Bill for the introduction of the decimal system is to be brought before the British Houses of Parliament at an early date.

6. Standardization in Electrical Industry.—The Executive Committee received a communication from the Electrical Association of Australia stating that they are appointing a standing sub-committee, comprising members in New South Wales and Victoria, to investigate the present position in regard especially to the lack of uniformity in the systems for the generation and distribution of electrical power and to make recommendations for its improvement. The Executive consider that this work is highly important, and have appointed Mr. F. Leverrier, K.C., to act as their representative on the New South Wales section of the sub-committee, and Professor T. R. Lyle, M.A., Sc.D., F.R.S., to act on the Victorian section.

The Electrical Association drew the attention of the Executive to the disabilities which the absence of recognised standards impose upon the electrical industry in Australia. In the first place there is no uniformity in the voltage of the alternating current supply in the capital towns, while the direct current voltages of the smaller country supply stations is almost as varied. As regards periodicity, the eastern States have adopted 50 periods for general work and 25 periods for railway work, while the new Western Australian Government scheme at Perth is 40 periods. Further, there are no Australian standards for voltage of transmission lines, for voltage of generation or for transformer ratios, nor are there any standards accepted in this country with regard to system of distribution, or for the rating of electrical machinery. This lack of uniformity imposes a serious and artificial handicap on the development of the electrical industry in Australia. Not only does the multiplicity of systems involve locking up of large amounts of capital in stocks, but it greatly adds to the difficulties of "linking up" and militates against the progress of local manufacture. The indirect effects in hampering development in the supply of cheap electrical energy are also serious. If, on the other hand, electrical systems in Australia were standardized, local manufacturers could standardize their designs and by means of quality production supply at lower prices.

Standardization in the direction indicated must necessarily be of somewhat slow growth, since a complete scrapping of existing non-standard plants and their immediate conversion to a standardized system would involve too great an expenditure of capital. The position is, however, becoming worse rather than better, and it is hoped that the work of the sub-committee will at any rate prevent immediately a further drift towards multiformity.

PART V.—THE BUREAU OF INFORMATION.

1. General.—In the original Report on the constitution and functions of the proposed Institute the Council were recommended to establish a Bureau “for the collection of industrial scientific information and its dissemination.” As mentioned in the First and Second Reports of the Executive, the Committee as a first step in this direction appointed a Science Abstractor, who took up his duties on the 20th July, 1916. Whilst primarily engaged in preparing reports and abstracts for the immediate use of the Executive (*see* paragraph 3 below), the Abstractor has devoted his remaining time to compiling a card index of information likely to be useful in the work of the Bureau of Information (*see* paragraph 4 below). The Executive are indebted to the Trustees of the Melbourne Public Library and to Mr. E. LaT. Armstrong (Chief Librarian) for their kindness in placing a special room in the institution at their disposal for the accommodation of the Science Abstractor.

2. Commonwealth Catalogue of Scientific Periodicals.—At an early stage of the work it was realized that the lack of catalogues of the scientific periodicals in Australian libraries made it impossible to ascertain whether a reference which could not be consulted in Melbourne was available in any of the other cities in the Commonwealth. It was therefore suggested that a work for the whole Commonwealth, on the lines of the late Dr. Hall’s *Catalogue of Scientific Periodicals in Melbourne Libraries*, would form a valuable foundation for the work of the Bureau of Information. The State Committees were asked to provide lists of the Public Libraries in each State likely to contain periodical scientific literature, and to furnish estimates of the cost of collecting information as to their contents.

It is suggested that about 200 libraries should be included, and the estimated cost of collecting the information is £220. The cost of publishing such a catalogue will, of course, be much greater, but as soon as the information has been collected it will be available to the public, as it will only be necessary to communicate with the Bureau of Information in order to ascertain the nearest library in which any particular journal can be consulted.

3. Preparation of Abstracts and Bibliographies.—In the case of a number of proposals that have come before the Executive it has been necessary to obtain additional information before they could be properly considered. In some cases this information has been obtained by research at the Melbourne Public Library. By this means reports on the following subjects were prepared, *viz.*:—Marram-grass in Australia; St. John’s Wort; the Production of Camphor; Mangroves; the Flax Industry; Commercial Glucose; Manufacture of Rennet Extract; Industrial Casein; By-products from Wool-scouring—Methods for their Recovery; Methods of Treating Feathers; Occurrence of Zinc Carbonate in Australia; the Cultivation of Maize in Australia; the Production of Industrial Alcohol and the design of Internal Combustion Engines using Alcohol as a Fuel. In addition, bibliographies on the following subjects have been compiled:—Recent Publications on the Educational Systems of Europe, America, and Australasia; Works on Denaturing Alcohol; Recent Literature on the Destructive Distillation of Woods other than Pine-woods.

In regard to a number of matters, the Executive Committee have thought it desirable to obtain information or opinions from theseveral State Committees. The replies to the inquiries thus made have often been accompanied by printed reports, &c., and it has been necessary to prepare summaries of the whole of the information thus received. In other cases numerous suggestions dealing with some special subject have been received, and have had to be combined in order that the subject might be considered as a whole. Summaries of this nature on the following subjects have been prepared, *viz.*:—Scheelite Deposits of Australia; Australian Clays; Occurrence of Alunite in Australia; Tannin in Australian Barks; Tan-barks of Western Australia; Marram-grass for Paper-making; Eradication of Prickly Pear; Insects damaging Stored Grain; the Blow-fly Pest; Opinions as to the Desirability of a Soil Survey of Australia; Proposed Methods for Collecting Information for a Soil Survey; Cotton-growing in Queensland; Proposals for the Encouragement of the Australian Flax Industry; Proceedings of the Inter-State Conference on Forestry; Australian Sources of Potash; Phosphatic Fertilizers; Occurrence, Composition, and Possible Utilization of Victorian Brown Coal; Opinions as to the Desirability of Altering the “Proof Spirit” Standard of Alcoholometry; Utilization of By-products in the Meat Industry; Dyes from Australian Sources; Grass-tree Gum; Utilization of Waste Timber; Forest Products.

A number of the reports listed above have been circulated to members of the State Committees, and a few have been supplied to persons engaged in industry.

4. Index of Scientific Journals. All published papers and articles utilized in the preparation of the reports and abstracts referred to in section 3 have been catalogued on a card index for future reference. In addition, all articles likely to be of value in papers and reports received by the Committee have been catalogued, together with all similar articles published in the following journals during the last six years:—

Agric. Gaz. of N.S. Wales; Journ. Agric., Victoria; Queensland Agric. Journal; Journ. Agric., S. Australia; Journ. Agric. Research (U.S.A.); Journ. Agric. Science (U.K.); Bulln. Imperial Institute; Journ. Roy. Soc., Victoria; Proc. Roy. Soc., Victoria; Proc. Roy. Soc., Queensland; Trans. Roy. Soc., S. Australia; Proc. Roy. Soc., Tasmania.

Some volumes of the following periodicals have also been catalogued:—

Journ. Bd. of Agric. (Great Britain); Kew Bulletin; Scientific Australian.

The entries have been arranged under over a thousand subject-headings, with subdivisions and cross-references, so that all the information on any subject at present collected can be turned up immediately.

5. Publication of Bulletins.—A number of short articles on various subjects dealt with by the Executive have been contributed to the press during the year. It is hoped in the near future to publish more comprehensive reports as separate bulletins, and the Executive have already decided to issue one on the more important diseases of stock, and another on the utilization of forest products.

PART VI.—THE WORK OF THE STATE COMMITTEES.

The following Reports have been furnished by the several State Committees at the request of the Executive:—

1. New South Wales.—The first meeting of the New South Wales State Committee was held in the Senate-room, University Chambers, on the 8th May, 1916. Through the kindness of the State Government a commodious and suitably-furnished room in the new Education Department building was placed at the disposal of the Committee. Arrangements were also made for an officer of the Education Department (Mr. H. Davies) to perform the necessary clerical work. As a general rule, the Committee meets on alternate Tuesdays, and altogether 25 meetings have been held since its inception. The time and energies of the Committee have been largely taken up with the making of inquiries on behalf of the Executive Committee and supplying the information acquired. This could sometimes be done as a result of the combined knowledge of the members, but information had frequently to be sought from others, who had an expert knowledge of particular subjects, either by means of correspondence or interviews. Individual members of the Committee also reported directly to the Executive on matters on which they had special knowledge.

Several inquiries came from people with reference to problems affecting their industries, and they were either supplied with the desired information or referred to Government Departments or other agencies who had the means of solving their difficulties. Certain larger problems affecting whole industries were brought under the notice of the Committee, and in one case the matter seemed sufficiently important to warrant us in recommending to the Executive the appointment of a Special Committee and the expenditure of a considerable amount of money to carry out research work in connexion with it. Several visits have been paid to factories either by individual members, sub-committees, or the Committee as a whole, and the principle was adopted of continuing such visits at all times when any matter under investigation appears to make them desirable. The Chairman and Professor Watt addressed the Industrial Section of the Royal Society on the aims and objects of the proposed Institute of Science and Industry and the work of the Advisory Council.

The co-operation of the State Committee was sought by the Executive in connexion with the preparation of an Industrial Census of the Commonwealth, and information was supplied by Mr. Trivett, Government Statistician, regarding the principal firms engaged in industries which might be expected to benefit from the result of a closer touch with scientific research. It is regrettable, however, that the necessary sum was not voted for the more complete catalogue of industries showing their distribution, relative importance, technical difficulties, &c., which Mr. Trivett was (and still is) willing to prepare.

In connexion with the "Problem Census," a circular was issued to all likely sources asking for information regarding problems in terms of the letter sent by the Executive, and notices were also issued to the press. The number of replies received was most disappointing, less than a dozen problems being submitted and sent on to the Executive. It seems very improbable that the list is anything like complete. Manufacturers evidently have objections to stating their difficulties in writing, and the Committee is of opinion that a full census could only be prepared as a result of personal interviews with all those likely to have problems to solve.

The Committee has seldom found it necessary to appoint sub-committees, although individual members have frequently been deputed to collect all available information on certain subjects. A sub-committee, however, investigated and reported on a suggestion for carrying out some research work with the object of obtaining an improved (and probably a standard) method for the production of tan liquors, especially from wattle-bark. A very good case was made out, as there is evidently a great deal of waste and lack of uniformity resulting from the present haphazard methods, and the Executive agreed to vote the sum of £450 for the necessary research. The Committee has felt considerably hampered in its activities by the temporary nature of their appointment and the rather unsatisfactory financial arrangements, and all hope that the time is not far distant when the Institute will be put on a proper footing by Act of Parliament.

2. Victoria.—The first meeting of this Committee was held on the 2nd May, 1916, when preliminary arrangements were made to carry out the desires of the Executive, as expressed in the communication from the Chairman. Mr. A. G. Millington, a member of the staff of the Directorate of Munitions, was appointed Secretary to the Committee. The compilation of the Industrial Census was intrusted to Mr. A. M. Laughton, Victorian Government Statistician, who arranged for necessary clerical assistance to have the work carried out, and the return was submitted to the Executive in August. The compilation of a Problem Census on the lines suggested by the Executive was fraught with many difficulties. Circulars were sent to all Associations, Societies, Institutes, &c., in Victoria which it was considered could provide desired particulars, but, speaking generally, no material information or assistance was received from this source. This poor result was probably due to the fact that associations formed in connexion with certain industries have up to the present been engaged mainly on questions as between employer and employee. Another factor contributing to lack of information by medium of circulars was that many very essential industries have no association which will enable those engaged in the industries to come together and discuss matters. An appeal was made through the press for information and suggestions, but this course also was not very successful. The impression gained by the Committee was that before any definite knowledge could be obtained as to difficulties experienced, it would be necessary to organize or bring together those engaged in certain industries. However, with the few particulars obtained from above sources, and by the aid of the members of the Committee, a preliminary census was completed and submitted to the Executive.

The Problem Census was not lost sight of, and, coupled with a desire to ascertain how scientific control of the processes and products of Victorian industries could be improved, the Committee decided to interview representatives of some of the firms engaged in certain industries. The Committee at the time also had in view the question of encouraging groups or classes of industries to enter into co-operation to secure scientific advice. Those interviewed comprised representatives of the cement, implement manufacturers, and iron trades, and much valuable information was obtained. As a result of the information received from these interviews, and of the work of the Committee during the year, a report was submitted to the Executive early in May, 1917, covering the whole position and submitting the following conclusions:—

- (a) The most important problems requiring research at the present time in Australia are ones bearing on the primary industries.
- (b) In general the existing secondary industries in Victoria are not at present in difficulties on account of unsolved problems requiring research. There is room, however, for great improvement, especially in the smaller shops in the technical details of manufacturing practice and in business management.
- (c) The chief obstacle to progress in the secondary industries is labour unrest. Until this is overcome there cannot be either industrial stability or advancement. The factor most likely to alleviate the present condition of things is the better education, scientific, technical and civic, of all persons concerned in industry.

The Committee also expressed the opinion that the Federal Institute of Science and Industry could give assistance to the secondary industries in the following ways, viz. :—

- (1) By conducting any necessary research.
- (2) By means of a bureau of information.
- (3) By organizing the means by which physical tests of materials could be rapidly and cheaply obtained.
- (4) By standardization of specifications.
- (5) By active propaganda carried on by an officer in each State who would act under the State Committee. Such an officer would be an organizer bringing under the notice of the manufacturers the activities of the Institute. He would ascertain their difficulties, and refer them to the proper place for solution. He could secure co-operation among the smaller shops in any one industry, explain and urge scientific management, and in many similar ways increase efficiency; costing, lay out of works and efficiency of labour would be matters on which the organizer could give advice.
- (6) Especial attention was drawn to the desirability of the Institute encouraging by its State Committees and organizers the formation of trade associations, such associations could assist in—
 - (a) The organization of the industry.
 - (b) The specialization of work amongst its members.
 - (c) The dissemination of technical information amongst its members.
 - (d) The establishment or appointment of analytical facilities for the routine work of its members at an arranged tariff.

(i) *Proof Gallon*.—As a result of evidence obtained and submitted by Mr. Russell Grimwade, the Committee recommended to the Executive that the existing methods for appraisement of alcohol in spirituous liquors be revised, that the "Proof Spirit" standard be abolished, and that valuation in terms of absolute alcohol by weight be substituted. Certain suggestions were made regarding preliminary steps necessary to effect a change, and the matter has been under consideration by the other State Committees and the Executive.

(ii) *Standardization of Designs of Scientific Apparatus*.—In June, 1916, a sub-committee was formed to inquire into and report on the standardization of designs of scientific apparatus used in schools and technical colleges, and which could be manufactured in Australia. This action was taken owing to restricted imports and the multifarious classes of instruments, &c., imported. It was considered that with standardization there would be a reasonable chance of Australia providing for its own requirements. As a result of the sub-committee's recommendations, a Federal Committee was formed to take the matter up, and approval has since been given for the engagement of a draftsman to provide necessary designs.

(iii) *Standardization of Designs and of Specifications*.—Evidence brought before the Committee during the year indicates that very valuable assistance could be rendered to manufacturers and users generally if the Institute took action in the direction of standardizing designs of articles and specifications of materials which are now being manufactured in Australia. For instance, in the case of cement the British specification is not suitable, on account of the chemical composition of Australian raw materials being different from British raw materials, and this has led to users in many cases drawing up their own specifications. A standard Australian specification would be of considerable help to the manufacturers, and save many difficulties. An instance in the case of designs is high voltage porcelain insulators. At present manufacturers are called upon to supply to many different designs, whereas one set of designs should suffice. If an official set of designs were brought out, it would save much time and trouble and would materially help the industry.

(iv) *Rennet and Pepsin*.—Owing to shortage of rennet threatening to interfere with the production of cheese, the Executive Committee in September, 1916, asked that inquiries be made as to the possibility of the production and utilization of rennet. Inquiries were made immediately, circulars being sent to all the principal butter and cheese factories with the object of ascertaining the quantity of calves' stomachs which would be available, and the possibility of organizing collection. Valuable information was obtained, and it has since been made available to firms contemplating manufacture of rennet. So far as the Committee has been advised, one firm has actually taken up the manufacture of rennet in Victoria, and has sent out its first orders comprising about half-a-ton, at a cost considerably below recent rates for the imported article. The Committee also understands that the product has stood well to test. The action taken by the Committee has helped considerably in establishing this new industry. Advice on this matter was given by Mr. A. E. V. Richardson, Superintendent of Agriculture, and a member of this Committee. He also submitted valuable information on the manufacture of pepsin and its use for cheese making; he also had tests made to prove the value of pepsin for that purpose. Particulars as to the manufacture of pepsin were supplied to the Executive, and subsequently circularized to meat companies for use in case they may consider it advisable to take up the manufacture.

(v) *Alcohol as a Fuel for Internal Combustion Engines.*—In November, Mr. Russell Grimwade raised the question of utilization of alcohol as a fuel for internal combustion engines, and certain recommendations were made to the Executive. As a result of these recommendations inquiries were instituted abroad as to the possibility of securing suitable engines for the purpose. In the meantime the position as regards supplies of petrol having changed, the Committee made further recommendations, as a result of which a Special Committee has been formed by the Executive to make full investigations into the matter.

(vi) *Brown Coal.*—At the request of the Executive, information was collected on this subject, and, as the Victorian Institute of Industries decided to proceed immediately with investigations, the information collected was passed on to the Institute to assist it in its work. The thanks of the Committee are extended to the following for valuable information supplied:—Dr. F. H. Campbell, Messrs. J. L. Wharton and W. L. Baillieu, and the Melbourne and Altona Colliery Company.

(vii) *Miscellaneous.*—In addition to the above-mentioned matters, information was obtained on the following subjects and submitted to the Executive, viz.:—Tannic acid from timbers, admission into Australia of scientific apparatus, Xanthorrhœa gum, sources of supply of phosphatic manures; lists of scientific and technical reports and bulletins were also submitted.

A few firms applied for information with the object of solving difficulties experienced in connexion with manufactures, and action was taken to put them in possession of reliable advice.

In conclusion, the Committee desires to place on record its appreciation of the action of Mr. W. L. Baillieu in placing the board-room of the Broken Hill Associated Smelters, Collins House, at its disposal for meetings.

3. Queensland.—The *personnel* of the Queensland Committee is such that represented on it are men personally identified with the pastoral, sugar, tanning, and leather industries. Woollen manufacturing was also directly represented at first, but owing to pressure of work the representative resigned. By means of circular letters and the press, every Agricultural Association, Progress Association, Shire Council, &c., in Queensland was made aware of the existence of the Advisory Council and its objects, and requests were made with respect to any investigations or any problems with which the Council might be concerned. The Queensland Chamber of Manufactures and the Queensland Chamber of Commerce were also directly communicated with, and personal relations established between these bodies and the Committee. In each case all branches and members of these Chambers throughout Queensland were circularized. The result of this has been that the Committee received a large number of communications, both through the agency of the associations and also direct from individuals engaged in industry or investigating special problems.

The Committee has met about once a fortnight since its inception on the 12th June, 1916, until quite recently, and has concerned itself with questions that have arisen in Queensland and those submitted to it by the Executive Committee. An office and clerk are shared conjointly with the State Advisory Munitions Committee. Every endeavour has been made to keep in as close touch as possible with the State Government and its activities, and this has been carried on mainly through the Minister for Agriculture and Stock, the Minister for Lands, the Home Secretary, and the several scientific experts in the Government Service.

With the aid of the Government Statistician the Committee was enabled to furnish information for the Industrial Census along the following lines:—

- (a) Return from Government Statistician showing the nature of manufactures, hands employed (male and female), and the salaries and wages paid.
- (b) Return from the Government Statistician showing a list of the manufacturers in Queensland.
- (c) Return from the Department of Labour showing the hands employed and wages paid in the various industries.
- (d) Return showing the average approximate quantity and value of raw produce derived and marketed annually from the pastoral and agricultural industries of Queensland.

The returns covered the information asked for with the exception of the capital invested, which the Committee was unable to obtain.

With respect to the Problem Census, the Committee experienced considerable difficulty in finding out anything really definite with respect to the general difficulties or disabilities which affect the development and progress of existing industries. It made a special effort through the Chamber of Manufactures, but up to the present has not met with much success. Several of the Committee's original inquiries were regarded

with suspicion, but in all cases the object of the inquiry was really appreciated, subsequent to either an interview or letter. The main difficulties under which the great pastoral and agricultural industries of this State suffer are well known, namely, the pests, such as prickly pear, blow fly, worm nodule, cane beetle, banana borer, cattle tick, &c. Just at present the banana and pine-apple industries are suffering seriously from a shortage of potash.

Sub-Committees have been appointed to investigate the following matters :—

- (a) Utilization of Molasses.—This involves the production of alcohol and its commercial application, also the product on of potash.
- (b) Tanning properties of mangrove and other barks.
- (c) Tuberculosis with special reference to cattle and pigs.

The Molasses and Tanning Sub-Committees are still pursuing their investigations, while the Tuberculosis Sub-Committee has completed its task, and 2,000 copies of its Report were printed by the Queensland State Government. These reports are in the course of distribution.

Special investigation has also been made of cotton-picking devices, cane cutters and harvesters, and prickly pear eradicators.

4. South Australia.—The first meeting was held at the office of the the Hon. Commissioner of Crown Lands on the 5th July, 1916, when Professor Rennie was elected Chairman, and at a subsequent meeting Mr. W. H. Mongan was appointed Secretary. The position of this Committee differs somewhat from those of the Committees in the other States, owing to the fact that the South Australian Government had already appointed an Advisory Committee of Scientific Research, to advise upon questions relating to scientific industrial research and to deal with the results of investigations. The carrying out of these researches is intrusted to the State Department of Chemistry, which was established by the Hon. the Minister of Industry.

In order to achieve the best results in connexion with the measures being taken by the State to assist local industries, it was deemed advisable to arrange that the Federal and State Committees should work in conjunction, to avoid overlapping. This policy has been followed. Furthermore, the Committee appointed by the State Government has been in a favorable position as regards the effective carrying out of definite scientific investigations, through being in touch with the Department of Chemistry, which has a permanent staff of trained chemists and a properly equipped chemical laboratory, for which financial provision is made in the Annual Estimates of Expenditure of the Government. So far, therefore, the work of this Committee has been largely confined to the collection of statistics and information not necessitating actual scientific work. The particulars thus acquired have been forwarded to the Executive Committee from time to time.

After the necessary preliminary arrangements had been made, it was arranged for the Government Statist to compile an Industrial Census of this State, and this has now been completed.

The proposed Problem Census has not yet been compiled in this State, as it was considered that the information published by the Department of Chemistry met requirements in this respect at present, and it was very doubtful whether a reliable census could be compiled, owing to the reluctance of some manufacturers to admit the necessity for any investigation or disclose the details of processes used by them. In some cases, also, the information afforded was not sufficient to enable any definite steps to be taken.

The following matters have been given attention since the inception of the Committee :—

- (i) *Cream of Tartar*.—The question of the production and utilization of Cream of Tartar was discussed, with a view to deciding upon the advisability of appointing a special committee to inquire into the matter, but the subject was postponed pending the publication of the results of an investigation which was being conducted in South Australia.
- (ii) *Grass Trees*.—Examinations of the resin produced by these trees were conducted in both Government and University laboratories.
- (iii) *Tanning Materials*.—Information was collected concerning the tannin contents of South Australian barks, and the preparation of tanning "extracts" from those portions of the trees which were not used in the ordinary tanning process. It was found that firms engaged in the tanning industry held the opinion that a systematic investigation of this subject would be of assistance in overcoming many of the difficulties connected with the industry.

- (iv) *Phosphatic Manures*.—The occurrence and use of rock phosphates in this State have been under consideration, and some valuable information has been collected, with the assistance of the Director of Agriculture and Director of Mines.
- (v) *Catalogue of Scientific Literature*.—Arrangements have been made for particulars to be supplied by various bodies possessing a supply of scientific and technical periodicals.
- (vi) *Miscellaneous*.—Amongst others, the following matters have received attention:—Tick Pest in Sheep; the Possible Spreading of the Sparrow Pest to Western Australia; the Estimation of Alcohol in terms of Absolute Alcohol in lieu of Proof Spirit; and the Importation of Scientific Instruments for Educational Institutions.

5. Western Australia.—The first meeting of this Committee was held in July, 1916. In October, Mr. I. H. Boas, M.Sc., was appointed Secretary. In addition to many minor matters, the following main questions have engaged the Committee's attention:—A Wheat Breeding Conference, the Utilization of Iron and Aluminium Phosphates and search for new deposits of Calcium Phosphates, Plant Acclimatisation, Grass-tree Gum, a Catalogue of Scientific Literature, Tanning Materials of Western Australia, Utilization of Timber Waste, Industrial Census, Soil Survey, Waste Paper, Low Temperature, Distillation of Coal, and a Forest Products Laboratory.

Efforts have been made to obtain from manufacturers a statement of the difficulties they encounter, and increased interest is being shown in the work of the Committee. Among matters raised in this way, the question of Red Gum Tannage is receiving special attention. A number of applications have been received from inventors for assistance in developing their ideas; but none have proved worthy of investigation. Most of the inventors refuse to disclose details, and so nothing can be done to assist them. Reports have been prepared and forwarded to the Executive dealing with Industrial Census, Waste Timber, Tanning Materials, Plant Acclimatisation, Catalogue of Scientific Literature, Grass-tree Gum, Phosphate Deposits, and Soil Survey.

Three Sub-Committees have been appointed as follow:—

(i) *Sub-Committee on Tanning Materials*.—This Committee consisted of Messrs. Rosenstamm (Chairman), Lane-Poole, Stacey, and Boas, and was appointed to make inquiries into the tanning materials of Western Australia, and especially into the use of Red Gum (*E. calophylla*). This Sub-Committee has since been appointed as a Special Committee by the Executive (see pages 14, 26, and 27 hereinbefore.)

(ii) *Sub-Committee on Plant Acclimatisation*.—The Hon. W. Kingsmill (Chairman), Professor Paterson, Dr. Stoward, and Mr. G. L. Sutton. This Committee has made a good deal of preliminary inquiry and has drafted a proposal for a system of stations for the trial of plants of economic value. The scheme includes all parts of the State from the North-West to the drier Eastern districts. Further progress is blocked by lack of a grant of money. The sum asked for is small and it is hoped that the Executive will shortly be able to make a recommendation that will enable the Committee to continue its work.

(iii) *Sub-Committee on Waste Timber*.—Mr. A. McNeil (Chairman), and Messrs. Lane-Poole, Mann, and Boas. This Committee has made inquiries into the prospects of the commercial utilization of waste timber by distillation and in turnery. This question of timber waste forms part of the work of a Forest Products Laboratory, and the Committee considers that this should be established without delay.

At the date of writing this Report the Committee finds that many problems of great importance to the primary and secondary industries of this State call for solution. During its brief existence it has worked earnestly towards this end, and it awaits with interest the foundation of the permanent Institute, which it is hoped will give to its work increased practical utility.

6. Tasmania.—A delay of several months occurred in the appointment of the Associate Members of this State Committee, and also in the appointment of a third full member of the Advisory Council, the result being that sufficient members were not available to make a quorum until the 7th March, 1917, when the first meeting was held. During the months of March, April, and May one meeting per month was held in order to enable the members to carefully consider the problems to be tackled, and it was arranged that after the third month of the State Committee's existence the meetings should be held fortnightly on the second and fourth Monday of each month. This practice is now in vogue, and from now on Committee meetings will be held accordingly. Mr. W. F. Vincent, B.E., of the Hydro-Electric Department, Hobart, has recently been appointed Secretary to the Committee, and this arrangement will enable the work of the Committee to be managed much more efficiently than has been possible in the past.

The following sub-committees have been appointed :—(a) Scientific Literature Sub-Committee ; (b) Geological and Mining Sub-Committee ; (c) Industrial Electricity Sub-Committee ; (d) Forest Products Sub-Committee ; (e) Fruit Industry Refuse Sub-Committee ; (f) Executive Sub-Committee.

In addition to the above standing sub-committees, special sub-committees have been appointed from time to time to investigate certain specific matters.

Up to date, the general policy of the State Committee has been to conduct inquiries throughout the State, giving attention to the possibility of anything being done in the State to assist (1) the prosecution of the war ; (2) the establishment of industries to manufacture articles to substitute for enemy products imported prior to the war ; (3) the consideration of industries which might, after the war, be advantageously established in the State.

The active life of the Committee has not been of sufficient duration to enable any positive proposals to be put forward. The investigations which have been made up to date have, unfortunately, been of a negative character, one consideration or another ruling the various proposals out as impracticable at the present moment. It is hoped, however, that in the near future more concrete proposals will be put forward towards the establishment of industries in the State at the termination of the war, and, possibly, one or two during the war. With regard to the co-operation of the persons engaged in industry, difficulties have been experienced so far, due to the fact that the industries already established here having a scientific leaning have not shown an inclination to co-operate closely with the Sub-Committee. Steps have been taken to formulate an Industrial Sub-Committee and to bring on to this leading industrialists, together with the anticipated co-operation of the local Chambers of Commerce and Manufactures to effect better results.

The particular matters which have received the attention of the State Committee during its brief existence are as follow :—

- (i) The preparation of a report setting out the facilities of the State Geological Department in the direction of its co-operation with the State Committee.
- (ii) The preparation of a catalogue of Scientific and Technical Literature.
- (iii) Consideration of the possibility of application of electricity to existing industries.
- (iv) Consideration of the scheduled imports into Australia with a view to obtaining indications which might lead to a substitution of local resources.
- (v) The question of utilization of local timbers.
- (vi) The question of utilization of forest waste products.
- (vii) The question of utilization of local timbers for paper pulp.
- (viii) The question of production of alkalies, aluminium, nitrates, white lead, cyanide, &c.
- (ix) The question of utilization of fruit and jam factory refuse.
- (x) The question of the utilization of posidonia fibre for fruit packing.

As has already been stated, conclusive and final results have not been attained in regard to a number of these questions, but it is expected that finality will be reached at an early date.

PART VII.—FINANCE.

1. General.—A grant of £5,000 was made by the Federal Government to cover the cost of the scientific work of the Advisory Council and of incidental expenses in connexion therewith. It was provided that the total expenditure in respect of fees payable to members of the Executive Committee should not exceed £2,000 per annum, and that the authority of the Government should be obtained for all expenditure out of the grant other than office expenses, &c. It was decided that the accounts work of the Advisory Council and payments on behalf of the Council should be effected through the Prime Minister's Department.

2. Expenditure.—The total expenditure incurred by the Advisory Council up to the 30th June, 1917, is £3,593, comprising £187 for expenses of the Advisory Council, £2,011 for fees and expenses of the Executive Committee, salaries of staff and incidental expenditure, £274 for State Committees, and £1,121 for Special Committees. The following statement gives particulars of the expenditure. The figures given are subject to slight revision, since it has not been practicable to obtain in all cases, at the date of publication of this Report, complete returns of expenditure of State and Special Committees up to the 30th June, 1917.

COMMONWEALTH ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

FINANCIAL STATEMENT OF EXPENDITURE.*

From 16th April, 1916, to 30th June, 1917.

	£		£
		Brought forward	2,198
1. <i>Advisory Council</i> —		3. <i>State Committees</i> —	
Travelling and out-of-pocket expenses of members attending meetings	160	New South Wales	65
Cost of reporting, typing, &c. ..	27	Victoria	91
		Queensland	49
2. <i>Executive Committee</i> —		South Australia	24
Attendance fees of members	603	Western Australia	43
Travelling and out-of-pocket expenses	352	Tasmania	2
Salaries of staff	761	4. <i>Special Committees</i> —	
Petty cash	59	Alcohol Fuel and Engines	11
Postage and telegrams	15	Alunite	427
Office furniture, stationery, printing, caretaker's attendance, hire of typewriting machines, &c.	221	Electrical Sterilization of Milk	3
		Ferro-alloys	137
Carried forward	2,198	Mode of Occurrence of Gold	340
		Tick Pest	49
		Worm-nest Investigation	81
		Worm-nodule Disease	25
		Yeast and Bread-making	48
		Total	3,593

* The figures given are subject to slight revision.

PART VIII.—CONCLUSION.

1. **The Organization and Work of the Permanent Institute.**—So far as is practicable, in view of the restricted financial resources and executive authority of the temporary organization, the Executive and State Committees have largely performed the functions for which the Advisory Council was created, and have prepared the way for the work of the proposed permanent Institute. The Executive consider that it is urgently desirable that steps should be taken for the establishment of the permanent Institute under statutory authority. The general features of the organization and work of the Institute were outlined in the Report of the Drafting Committee of the Conference convened by the Prime Minister in January, 1916. That Report was approved provisionally by the Commonwealth Government. In March, 1917, the Executive Committee concluded that it was desirable that they should be in a position to make further definite suggestions regarding the permanent Institute in the light of the experience gained in the course of the work of the temporary organization. They accordingly asked for and received opinions and suggestions from the Chairmen of the several State Committees, who were informed that they were free to consult their respective Committees on the matter if they desired to do so. This was generally done. Having carefully considered the suggestions and recommendations received from the Chairmen of the State Committees, the Executive drafted and adopted a Report, which substantially embodies the recommendations of the original Drafting Committee, but comprises also such amendments and additions as have been found desirable after a year's experience. Copies of that Report have been sent to members of the Advisory Council.

2. **Staff.**—Mr. Gerald Lightfoot, M.A., who was Secretary of the Committee of Conference which drafted the scheme of the Institute, and who afterwards visited America and Great Britain with the Prime Minister to inquire into similar activities in those countries, was appointed Acting Secretary by the Executive Committee on the 5th October, 1917. A memorandum by Mr. Lightfoot on the "Organization of Scientific Research Institutions in the United States of America" was published as a Commonwealth Parliamentary Paper in December, 1916.

Mr. W. B. Alexander, M.A., Keeper of the Department of Biology in the Western Australian Museum, was appointed by the Executive Committee to the position of Science Abstractor, and took up his duties on the 20th July, 1916.

3. Acknowledgment.—The Committee desire to express their appreciation of the kindness of the Inter-State Commissioners in providing accommodation at their offices for the Staff and for the meetings of the Advisory Council and of the Executive.

Further they wish to acknowledge the valuable assistance they have received from a large number of persons throughout the Commonwealth, including correspondents who have forwarded valuable suggestions and information, and authorities on various subjects who have been good enough to attend meetings of the Executive to place their knowledge of these subjects at the disposal of the Committee.

Their thanks, and those of the Commonwealth as a whole, are also due to the numerous individuals who are voluntarily giving their time and skill in the hope of solving the various problems dealt with in this Report.

In conclusion, they desire to place on record the efficient services of the Office Staff, which has spared no pains to further the work on which the Committee have been engaged during the year.

(Signed) ORME MASSON,
Deputy Chairman.

(Signed) GERALD LIGHTFOOT,
Acting Secretary.

314 Albert-street, East Melbourne,
30th June, 1917.



COMMONWEALTH OF AUSTRALIA.

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

REPORT

OF THE

EXECUTIVE COMMITTEE

OF THE

COMMONWEALTH ADVISORY COUNCIL OF SCIENCE
AND INDUSTRY

FOR THE

YEAR ENDED 30TH JUNE, 1918.

Prepared under the Authority of

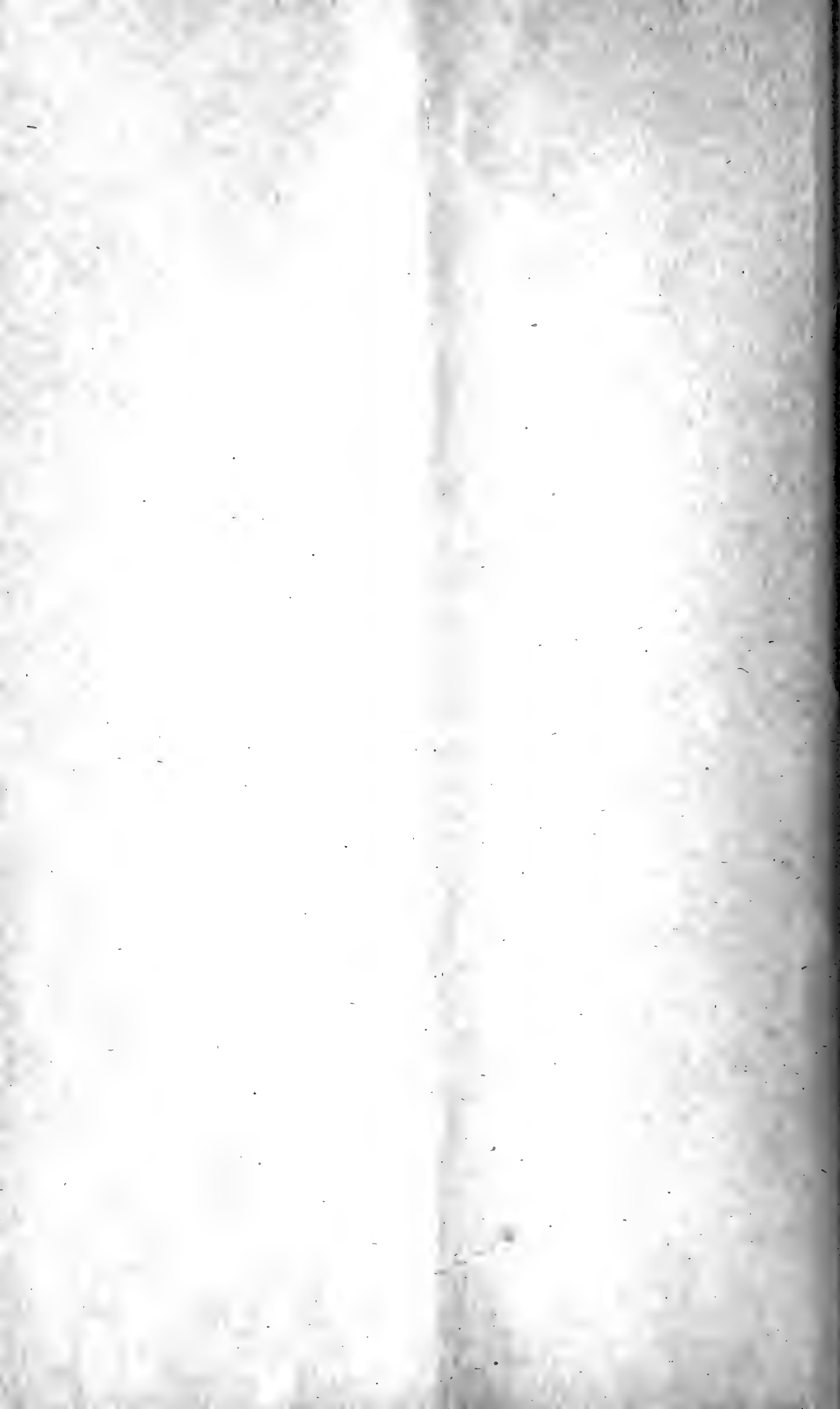
SENATOR THE HON. E. J. RUSSELL,

Vice-President of the Executive Council

(VICE-CHAIRMAN OF THE ADVISORY COUNCIL).

MELBOURNE, 31ST JULY, 1918.

Printed and Published for the GOVERNMENT of the COMMONWEALTH of AUSTRALIA by H. J. GREEN,
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COMMONWEALTH ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

REPORT OF EXECUTIVE COMMITTEE, 1917-18.

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COMMONWEALTH OF AUSTRALIA.

ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

REPORT OF EXECUTIVE COMMITTEE FOR THE YEAR 1917-18.

PART I.—INTRODUCTION.

1. General.—In the introductory sections of the Report of the Executive Committee up to the 30th June, 1917, information was given relating to the steps taken in the year 1916 by the Prime Minister (the Right Hon. W. M. Hughes, P.C., M.P.) to establish the Advisory Council of Science and Industry, which is a temporary body, designed to prepare the ground for a proposed permanent Institute of Science and Industry, and to exercise in a preliminary way the functions that will in future belong to the Institute. In the previous Report attention was directed to the fact that the main objects for which the temporary organization was established had been largely carried out. The permanent Institute has, however, not yet been established, and the Advisory Council has continued its work during the financial year under review. The work has been carried out by the Executive Committee, the State Committees, and by Special and Standing Committees which have been appointed either to inquire into and report upon particular matters or to carry out actual experimental work.

In the last Report of the Executive Committee information was given regarding the policy and nature of the work of the Committee under the following headings:—

- (1) Collection of Information for Use of Committees and of Permanent Institute—
 - (a) The Problem Census.
 - (b) The Industrial Census.
 - (c) Laboratories for Scientific Research and their *Personnel*.
 - (d) The Training and Supply of future Scientific Investigators.
 - (e) Technical Education and the Training of Artisans.
 - (f) Register of Research Work in Progress in Laboratories.
 - (g) Register of Experimental Work in Progress at Government Experimental Farms.
 - (h) Miscellaneous.
- (2) Establishment of Relations with other Authorities.
- (3) Encouragement and Co-ordination of Researches already in Progress.
- (4) Initiation of new Researches.

As the preliminary work referred to above was completed before the beginning of the financial year 1917-18, it is not dealt with again in this Report.

2. The Executive Committee.—During the year 1917-18 the following have been appointed members of the Executive Committee:—F. M. Gellatly, Esq., LL.D., W. Russell Grimwade, Esq., B.Sc., C. S. Nathan, Esq., A. E. V. Richardson, Esq., M.A., B.Sc., and Professor J. Douglas Stewart, B.V.Sc., M.R.C.V.S.

Dr. Gellatly has been appointed by the Commonwealth Government to the position of Chairman of Directors of the permanent Institute, but pending the appointment of his two colleagues and the passing of the necessary legislative measure for the establishment of the permanent Institute, the Government has appointed him a member of the Advisory Council and of the Executive Committee.

In order that the Executive and State Committees may keep in touch with each other, the Chairman of each State Committee is *ex officio* a member of the Executive, and receives copies of the Executive's minutes. Similarly the Executive receives copies of the minutes of each State

Committee. In order to bring the Executive and the State Committees into still closer touch, each member of the Advisory Council is furnished periodically with a statement summarizing the proceedings, other than routine business, of the Executive Committee.

Arrangements have also been made for each member of the Commonwealth Cabinet and of the recently constituted Commonwealth Board of Trade to be furnished each month with a brief *résumé* of the more important business of the Executive Committee.

The members of the Executive Committee are as follow, viz. :—

Members of Executive Committee, 30th June, 1918.

Chairman : The Hon. W. A. Watt, M.P., Acting Prime Minister.

Vice-Chairman : Senator the Hon. E. J. Russell, Vice-President of the Executive Council.

Deputy Chairman : Professor D. Orme Masson, M.A., D.Sc., F.R.S.

G. D. Delprat, C.B.E.

F. M. Gellatly, LL.D.

W. Russell Grimwade, B.Sc.

Professor T. R. Lyle, M.A., Sc.D.,
F.R.S.

E. A. Mann, F.I.C.

C. S. Nathan.

A. B. Piddington, K.C.

A. E. V. Richardson, M.A., B.Sc.

Professor J. Douglas Stewart, B.V.Sc.,
M.R.C.V.S.

Professor R. D. Watt, M.A., B.Sc.

Ex Officio Members (Chairmen of State Committees).

New South Wales : F. Leverrier, K.C.

Victoria : Professor T. R. Lyle, M.A., Sc.D., F.R.S.

Queensland : Major Alex. J. Gibson, A.M.I.C.E.; J. B. Henderson, F.I.C. (Acting Chairman).

South Australia : Professor E. H. Rennie, M.A., D.Sc.

Western Australia : Professor J. W. Paterson, B.Sc., Ph.D.

Tasmania : Major J. H. Butters, M.I.E.E., M.A.I.E.E., M.A.S.C.E.; H. W. Gepp (Acting Chairman).

During the year 1917-18, the Executive Committee has held altogether 72 meetings, its rule being to meet on one or two evenings of each week. Each meeting has occupied, on the average, 2½ hours. The nature of the business transacted will appear below. The following statement gives particulars of the attendance of each member at the meetings of the Executive during 1917-18 :—

Executive Committee Meetings.—Particulars of Attendance of Members.

Name.	No. of Meetings attended.	Name.	No. of Meetings attended.
Professor Masson	72	Mr. H. W. Gepp (Tas.)	5
Professor Lyle	68	Professor Paterson (W.A.)	4
Mr. W. R. Grimwade (a)	47	Professor Watt (N.S.W.)	4
Mr. A. B. Piddington (b)	36	Mr. E. A. Mann (W.A.)	3
Mr. G. D. Delprat (b)	30	Mr. C. S. Nathan (W.A.) (g)	3
Mr. A. E. V. Richardson (c)	20	Professor Rennie (S.A.)	1
Professor Douglas Stewart (d)	16	Mr. J. B. Henderson (Qld.)	1
Major A. J. Gibson (e)	12	Mr. F. Leverrier (N.S.W.)	1
Dr. F. M. Gellatly (f)	6		

(a) Not appointed member until 8th August, 1917. (b) Frequently absent from Melbourne. (c) Not appointed member until 8th August, 1917; absent from Australia for several months. (d) Resident in New South Wales during greater part of year; not appointed member until 8th August, 1917. (e) Absent from Australia for several months. (f) Not formally appointed member until 27th June, 1918. (g) Not appointed member until 21st February, 1918.

3. The State Committees.—The chief functions of the State Committees are to collect locally such information as may be required by the Executive and to forward to the Executive such recommendations as local knowledge or local inquiries may suggest. They have no independent executive or financial powers, but they are an extremely important part of the business machinery. The Executive Committee has had ample proof of this, and is convinced that, in the absence of some such organizations, no central body located in Melbourne could maintain proper relations with the representatives of Science and Industry in other parts of Australia.

The State Committees, as at present constituted, are as follow :—

Members and Associate Members of State Committees, 30th June, 1918.

New South Wales.

J. T. Elliott, D.Sc.	Professor J. Douglas Stewart, B.V.Sc., M.R.C.V.S.
Professor C. E. Fawsitt, D.Sc., Ph.D.	Minister for Agriculture (<i>ex officio</i>), Hon. W. C. Grahame, M.L.A.
F. B. Guthrie, F.I.C., F.C.S.	J. B. Trivett, F.R.A.S., F.S.S. (Assoc. Member).
F. Leverrier, K.C. (Chairman).	
A. B. Piddington, K.C.	
Professor R. D. Watt, M.A., B.Sc. (Hon. Sec.)	

Victoria.

W. T. Appleton.	Professor D. Orme Masson, M.A., D.Sc., F.R.S.
D. Clark, M.M.E., B.C.E.	A. E. V. Richardson, M.A., B.Sc.
G. D. Delprat, C.B.E.	Hon. G. Swinburne.
F. M. Gellatly, LL.D.	W. P. Wilkinson, F.I.C.
W. Russell Grimwade, B.Sc.	Minister for Agriculture (<i>ex officio</i>), Hon. D. S. Oman, M.L.A.
Sir John M. Higgins, K.C.M.G.	A. M. Laughton, F.I.A. (Assoc. Member).
Professor T. H. Laby, M.A.	
Professor T. R. Lyle, M.A., Sc.D., F.R.S. (Chairman).	

Queensland.

Major Alex. J. Gibson, A.M.I.C.E. (Chairman).	Hon. W. R. Crampton, M.L.C. (Assoc. Member).
J. B. Henderson, F.I.C. (Acting Chairman).	A. J. Gibson, D.Sc. (Assoc. Member).
Minister for Agriculture (<i>ex officio</i>), Hon. W. Lennon, M.L.A.	J. Gibson (Assoc. Member).
N. Bell, A.M.I.C.E. (Assoc. Member).	H. C. Richards, D.Sc. (Assoc. Member, Hon. Sec.).

South Australia.

G. Brookman.	Professor E. H. Rennie, M.A., D.Sc. (Chairman).
W. W. Forwood.	Minister for Agriculture (<i>ex officio</i>), Hon. E. A. Anstey, M.H.A.
W. A. Hargreaves, M.A., D.Sc., B.C.E.	

Western Australia.

E. A. Mann, F.I.C.	S. Bennett (Assoc. Member).
C. S. Nathan.	C. E. Lane-Poole (Assoc. Member).
Professor J. W. Paterson, B.Sc., Ph.D. (Chairman).	A. Gibb-Maitland, F.G.S. (Assoc. Member).
J. W. Sutherland.	A. Montgomery, M.A., F.G.S. (Assoc. Member).
Minister for Agriculture (<i>ex officio</i>), Hon. C. F. Baxter, M.L.A.	G. L. Sutton (Assoc. Member).

Tasmania.

Major J. H. Butters (Chairman).	Professor J. H. Mackay, M.C.E. (Assoc. Member).
J. L. Glasson, M.A., D.Sc.	H. M. Nicholls (Assoc. Member).
H. W. Gepp.	L. Rodway, C.M.G. (Assoc. Member).
Minister for Agriculture (<i>ex officio</i>), Hon. J. B. Hayes, M.H.A.	C. H. Slaytor (Assoc. Member).
H. J. Colbourn (Assoc. Member).	W. H. Twelvetees, F.G.S. (Assoc. Member).

The members of the State Committees are also members of the Advisory Council, while the Chairmen of the State Committees are *ex officio* members of the Executive Committee. Arrangements were made when the State Committees were originally constituted whereby they could be strengthened by the appointment of Associate Members representative of particular branches of science or industry. The Associate Members of the State Committees are not members of the Advisory Council.

PART II. —THE PERMANENT INSTITUTE OF SCIENCE AND INDUSTRY.

1. Report and Recommendations by Advisory Council.—A meeting of the Advisory Council was held in July, 1917, for the purpose of discussing a report on the organization and work of the proposed permanent Institute which the Executive Committee had drafted after consultation with the State Committees. The general features of the organization and work of the proposed Institute were originally outlined in the Report of the Drafting Committee of the Conference convened by the Prime Minister in January, 1916, and that Report was provisionally approved by the Commonwealth Government. In view, however, of the statements made that the Commonwealth Government intended to proceed with the creation of the permanent Institute, the Executive Committee considered it desirable to prepare a more detailed scheme than that outlined in 1916. The Executive accordingly invited the Chairmen of the several State Committees to state their views on the question, and in issuing this invitation the Chairmen were informed that they were free to consult the respective State Committees on the matter if they desired to do so. This was generally done.

The Executive Committee carefully considered the Report of the original Drafting Committee, in the light of the experience gained in the course of the work of the temporary organization, and in the light of the views expressed by the Chairmen of the State Committees. The Executive was of the opinion that, while the scheme outlined in the original Report should be substantially adhered to, certain modifications were desirable.

The Executive Committee accordingly submitted for the consideration of the Advisory Council a Report which was substantially that of the original Drafting Committee, but embodied also the amendments and additions which had been found desirable after a year's experience.

In the Report in question the Executive Committee pointed out that as a result of the experience gained in the course of its work, it was greatly impressed with the magnitude and possibilities of the proposals made by the Prime Minister in January, 1916, and was strongly of opinion that the time had arrived for initiating on a permanent basis the extensive scheme of scientific research work in connexion with industry which he outlined.

The Committee stated that it was convinced that the results of properly-conducted investigations into many of the subjects referred to by the Prime Minister would amply repay considerable expenditure, and would fully justify a bold and comprehensive policy being adopted. Not only would the results be a greatly increased productivity and output in many directions—in both primary and secondary industries—but the stimulus generally given to scientific research in relation to our industries would exert a powerful influence on our educational institutions, and bring them and the industrial community to realize the commercial value of science more fully than hitherto. In fact, the initiation of the scheme would, in the opinion of the Committee, go far to inaugurate a new era in the economic industrial life of the Commonwealth.

After discussion of the Report *seriatim*, it was adopted by the Advisory Council, and was subsequently considered at a meeting of the Council with the Prime Minister, who approved of the general principles of the Report and Recommendations, which have been published by the Executive Committee as a separate document.

2. General Nature of Work of Permanent Institute.—The Advisory Council recommended in its Report that the researches and the other work initiated by it should be continued by the permanent Institute, and, in addition, indicated the general nature of the work which it recommended should be carried out during the first years of the development of the permanent Institute. These recommendations were classified under the following heads:—

A.—RESEARCH WORK.

(i) *Agricultural and Pastoral*—

- (a) *Plant Genetics*.—The breeding and testing of new varieties of plants, &c., especially in relation to drought-resistant types of cereals and to salt-bushes, fodder-plants, &c., suitable for dry areas, and especially with a view to co-ordinating the work of State Agricultural Departments.
- (b) *Plant Pathology, Pests, &c.*—Remedial measures for diseases of plants, fruits, &c., and for weeds, noxious plants, and pests, especially the prickly-pear.
- (c) *Soil Fertility and Bio-Chemistry*.—The improvement of relatively unproductive soils, by the use of fertilizers and improved cultural methods, especially with a view to co-ordinating the activities and developing the work of State Departments of Agriculture.

- (d) *Animal Husbandry*.—The breeding and feeding of stock, and investigations with a view to the improvement and development of dairy products, especially in co-operation with State Agricultural Departments, Pastoralists' and Farmers' Associations, &c.
- (e) *Animal Pathology*.—The control and eradication of diseases of stock, whether parasitic or other, especially the tick-pest, nodule disease, and sheep blow-fly.
- (f) *Agricultural Economics*.—Economic Biology; the study of plants, &c., with a view to their industrial utilization (*e.g.*, for dyes, paper-pulp, tannin, industrial alcohol, fibres, &c.); the introduction of new industries (*e.g.*, cotton-growing), and of new improved appliances (*e.g.*, mechanical cotton-picker and sugar cane-cutter).
- (ii) *Forestry*.—Timber-seasoning and preservation, the utilization of forest products, the elimination of waste, and the establishment of new industries, such as paper-pulp, destructive distillation, utilization of by-products, &c.
- (iii) *Mining, Metallurgy, &c.*—Improved methods, especially electrolytic and flotation processes; the elimination of waste, the utilization of low-grade ores, the development of new mineral industries, such as clay-products, alunite, &c.
- (iv) *Manufacturing Industries*—
 - (a) The development by known methods of existing and new industries, especially those related closely to primary industries (*e.g.*, tannin and dyes, potash, phosphatic fertilizers, posidonia fibre, paper-making, tartaric acid, lanoline, industrial alcohol, forest products, clays and clay products, drugs and chemicals, and other commodities now imported).
 - (b) The elimination of difficulties met with by manufacturers.
 - (c) The establishment of new industries by new methods or processes.

B.—STANDARDIZING WORK.

The Advisory Council recommended that the following standardizing work be carried out, viz. :—

- (a) The standardization of scientific apparatus and instruments.
- (b) The testing of electric lamps, apparatus, and machinery.
- (c) The testing of instruments of precision used in industry.
- (d) The physical testing and standardization of materials used in industry and by the Commonwealth Government.

The Advisory Council also recommended—

- (a) That the Institute should carry out standardizing work for State Government Departments when requested to do so; and
- (b) That it should be empowered to charge fees for standardizing work, subject to Regulations approved by the Governor-General in Council.

C.—THE BUREAU OF INFORMATION.

An important feature of the work of the Institute would be the collection and dissemination of scientific and technical information affecting existing industries, or likely to lead to the establishment of new industries. For this purpose the Advisory Council recommended that the permanent Institute should establish a Bureau of Information, to bring information already available, as well as the results of the investigational work of the Institute, before agriculturists and manufacturers, by means of circulars, press notices, &c., and to furnish information by correspondence or personal interview.

The State Committees attach great importance to the establishment in the several States of branches or agencies of the Bureau of Information.

3. The Question of National Laboratories. For the purpose of carrying out the research work of the Institute, the Advisory Council expressed the opinion that existing laboratories should be utilized as far as suitable and available. In view, however, of the experience gained in the course of the work of the temporary organization, the Council has formed the opinion that it will be impracticable for the research work of the Institute to be carried out efficiently and economically solely at existing laboratories. Government laboratories are devoted largely to work of a routine nature, while the staffs of University laboratories are ordinarily occupied too much with instructional and other duties to give the continuous and prolonged attention which is necessary for the successful and speedy solution of industrial scientific problems. Moreover, existing laboratories are not ordinarily equipped with apparatus for conducting the "large-scale" experiments which are often necessary as an intermediate step between the solution of a problem in the laboratory and the profitable application of the laboratory results on a commercial basis. Further, the accommodation available in, and the staff and equipment of, existing laboratories in Australia are insufficient for the carrying out of the fundamental work which must be done before many pressing problems can be solved.

The whole situation is at the outset necessarily too complex to enable any logical scheme to be put forward indicating the extent to which the researches should be carried out at National Laboratories, on the one hand, and at existing institutions, on the other.

The Advisory Council is, however, of the opinion that, in order to provide full facilities for the research work which is necessary before effect can be given to the scheme outlined by the Prime Minister, National Laboratories should be established for investigations in the following branches of science and technology, viz. :—

- (i) *Plant Industry* (especially in relation to cultivation in arid or semi-arid regions, and to the control of weed pests).
- (ii) *Animal Industry* (especially in connexion with the control of pests and diseases).
- (iii) *Industrial Chemistry and Metallurgy* (technological research).
- (iv) *Industrial Standards* (scientific instruments, electrical apparatus, and materials used in industry).
- (v) *Forest Products* (especially preservation and seasoning of timbers, utilization of waste wood, &c.).

At the outset it will not be desirable, even if possible, to erect complete laboratories and equip them fully : but sufficient provision should be made as soon as possible for the more pressing work in each of the above departments, with arrangements for extension later on.

4. Other Resolutions Passed by the Advisory Council.—In addition to dealing with the matters referred to in the preceding paragraphs, the Advisory Council, at the meeting held in July, 1917, passed the following resolutions :—

1. That the Advisory Council is of the opinion that the immediate establishment of the permanent Institute is a matter of urgency, as the financial and executive powers of the temporary organization are wholly inadequate to the purposes in view.
2. That in the work of the future Institute provision be made for co-operation between the Commonwealth and State Governments. It is suggested that this might be effected by arranging for the estimates of expenditure of the Institute to be discussed at the Premiers' Annual Conference.
3. That the following representations be made to the Prime Minister, viz. :—
 - (a) That the various State Governments are at present anxious to undertake a number of investigations, with a view to developing industries of importance to their respective States, and in some instances are already taking steps in that direction.
 - (b) That the initiation of such researches will overlap the work of the proposed Commonwealth Institute.

- (c) That in many cases the State Governments are holding their hands pending the organization of the Commonwealth enterprise. Thus, the proposals for a Commonwealth Institute are retarding rather than stimulating scientific research in Australia.
 - (d) That this position is felt to be very unsatisfactory by the State Governments who, in some instances, intend to proceed on their own account unless the Commonwealth proposals are quickly materialized. Such action will limit the usefulness of the Institute, and prevent a favourable opportunity being availed of to obtain the co-operative assistance of the State Governments.
 - (e) That on these grounds the permanent Institute should be established at once.
4. That the Council strongly supports the recommendations made by the Executive Committee to the Commonwealth Government that conferences of (a) agricultural experts, and (b) authorities on technical education be held at an early date, and urges the Government to give effect to these recommendations.*
 5. That in the opinion of the Advisory Council the proposed Institute could not be satisfactorily worked if established as an adjunct to any of the existing Commonwealth Government laboratories.

PART III.—INVESTIGATIONAL COMMITTEES AND CONFERENCES.

1. Procedure followed.—As regards investigational work, the Executive Committee has continued and developed its policy of carrying out such work through the medium of Special Committees. These Committees consist in each case of the best experts available, both on the scientific and industrial side, whether members of the Advisory Council or not. In this way the Executive is able to obtain the advice and assistance on any particular problem of the leading minds throughout the Commonwealth. Particular attention has been paid by the Executive to secure adequate representation on these Committees of manufacturers and other persons engaged in industry, both primary and secondary, and much benefit has been derived from this combination of the scientific and industrial points of view.

The Special Committees may be divided into two classes, viz.:—(a) those appointed to carry out actual experimental work; and (b) those appointed to review existing information and to report as to the best lines of future investigation. In the former class are, for instance, the Special Committees on the extraction of potash and alumina from alunite, the production of ferro-alloys suitable for the manufacture of high-speed tool steels, the tanning properties of Queensland mangroves, substitutes for tin-plates for containers, the life-history of the cattle-tick, and the commercial utilization of kelp. In the latter class are, for instance, the Committees on tuberculosis in stock, on the nitrogen requirements of Australia, and on the damage by insects to stored grain.

There are, of course, no hard-and-fast lines of distinction between the two classes of Committees. In some cases a Special Committee, *e.g.*, the Committee on Alcohol Fuel and Engines, may be appointed to carry on both classes of work, while, in others, a Committee in class (b) having made its report may then proceed to carry out experimental work under a grant made by the Executive. The Special Committees report directly to the Executive, to whom they are responsible. Progress reports are received, ordinarily every two or three months.

In cases where the work is of a prolonged nature, or where a number of different matters are referred from time to time for report, the Executive has appointed Standing Committees. Examples of the former class are the Standing Committees on Seed Improvement and on Native Grasses and Fodder Plants, while an example of the latter class is the Standing Committee on Chemicals.

The members of the Special and Standing Committees act in a purely honorary capacity. Only out-of-pocket and travelling expenses are paid, and then only in the case of members attending from a distance the meetings of their respective Committees. The Executive Committee desires to express its cordial thanks to the members of the Special Committees for the valuable services they have rendered. Without their assistance it would have been impracticable for the Executive to have carried on its investigational work efficiently.

* The former of these conferences was held at Melbourne in November, 1917.

In certain cases where Investigational Committees have been appointed by some organization or authority other than the Advisory Council of Science and Industry, the Executive Committee has adopted the policy of making grants to such Committees, and of appointing representatives on them. Instances of this are the grants to the Society of Chemical Industry of Victoria, and to the New South Wales Pastoral Committee for the Investigation of the Blow-fly Pest.

2. Special Committees. Particulars of the Special Committees appointed up to the 30th June, 1918, are given in the following tabular statement. The total number of Committees appointed is 34. The total amount of the grants made during the year 1917-18 is £6,010, but no grant has been made to several of the Committees.

PARTICULARS OF SPECIAL COMMITTEES APPOINTED UP TO THE 30th JUNE, 1918.

Subject.	Date of Appointment.	Personnel.	Grants made during Financial Year, 1917-18.
1. Ferro-Alloys	15th June, 1916	Messrs. A. J. Higgin (Chairman), W. N. Kernot, and E. J. C. Rennie	£240 for working expenses
2. Mode of Occurrence of Gold in Quartz (a)	15th July, 1916	Prof. Skeats (Chairman), and Messrs. E. C. Dyason, H. Herman, and Dr. F. L. Stillwell	£400 for employment of investigator and £100 for working expenses
3. Tick Pest (b)	21st July, 1916	Prof. J. D. Stewart (Chairman), Drs. S. Dodd, T. Harvey Johnston, and J. A. Gilruth, and Messrs. G. E. Bunning, A. H. Cory, D. J. Kerr, J. Kidd, C. J. Pound, W. A. N. Robertson, and S. T. D. Symons	Nil
4. Alunite (c)	1st August, 1916	Mr. A. J. Higgin (Chairman), Prof. Masson, and Mr. V. G. Anderson	£225 for working expenses and employment of assistant
5. Yeasts and Bread-making	2nd August, 1916	Prof. H. G. Chapman (Chairman) and Mr. J. Nangle	£50 for payment of assistant and for equipment and working expenses
6. Nodule Disease in Cattle (d)	2nd August, 1916	Drs. S. Dodd (Chairman), A. Breinl, J. B. Cleland, J. A. Gilruth, T. H. Johnston, D. J. Kerr, W. Nicoll, and G. Sweet, Prof. S. J. Johnston, and Messrs. G. E. Bunning and T. A. Field	Nil
7. Damage by Insects to Grain in Store (e)	14th December, 1916	Messrs. L. Rossell (Chairman) and W. W. Froggatt and Prof. Haswell	£10 for expenses
8. Electrical Sterilization of Milk	21st December, 1916	Dr. J. B. Cleland (Chairman) and Mr. W. H. Myers	£100 for working expenses
9. Tanning Properties of Queensland Mangroves	13th February, 1917	Messrs. J. Gibson (Chairman), L. S. Bagster, and J. B. Henderson	Nil
10. Tanning Properties of Red-gum in Western Australia	20th February, 1917	Messrs. B. Rosenstamm (Chairman), I. H. Boas, C. E. Lane-Poole, and Prof. Tattersall	£300 for employment of assistant and working expenses
11. Means of Transmission of Worm-nodule Parasite	27th February, 1917	Prof. S. J. Johnston (Chairman) and Dr. J. B. Cleland and Prof. J. D. Stewart	£650 for travelling and out-of-pocket expenses and payment of assistants
12. Control of Sparrow Pest ..	1st March, 1917	Captain S. A. White	Nil
13. Alcohol Fuel and Engines (f)	8th March, 1917	Prof. Lyle (Chairman), and Messrs. T. Baker, W. R. Grimwade, Dr. P. Harker, and Messrs. W. N. Kernot, H. V. McKay, and G. Lightfoot (Secretary)	£500 for working expenses
14. Classification of Imports of Chemicals	19th April, 1917	Mr. W. R. Grimwade (Chairman), Dr. F. H. Campbell, and Mr. E. T. McPhee	Nil
15. Tanning Methods of New South Wales	24th April, 1917	Prof. Fawsitt (Chairman), and Messrs. B. Bailey, F. A. Coombs, F. B. Guthrie, and H. G. Smith	£250 for employment of assistant
16. Posidonia Fibre	22nd May, 1917	Prof. J. Read and Mr. H. G. Smith	£150 for working expenses and employment of assistant
17. Grass-tree	19th June, 1917	Prof. Rennie (Chairman), Dr. Cook, and Messrs. Finlayson and Hurst	£50 for purchase of chemicals and expenses
18. Purification of Damaged Wheat by Lime (e)	27th July, 1917	Mr. L. Rossell (Chairman), Dr. R. J. Bull, Mr. W. W. Froggatt, Dr. W. H. Green, Professors W. A. Haswell, T. R. Lyle, and D. O. Masson	£45 for expenses
19. Mechanical Cotton-picker	7th August, 1917	Messrs. N. Bell (Chairman), D. Jones, and P. L. Weston	£250 for employment of mechanic and expenses
20. Utilization of Australian Phosphatic Rocks	14th August, 1917	Mr. A. E. V. Richardson (Chairman), Professors Masson, Paterson, and Watt, Dr. H. Green, and Messrs. F. B. Guthrie and G. L. Sutton	Nil
21. Life-history of Cattle Tick	31st August, 1917	Hon. C. Booker, M.L.A. (Chairman), Dr. T. H. Johnston, and Mr. A. H. Cory	£1,200 for assistants and expenses
22. Catalogue of Scientific and Technical Periodicals	7th September, 1917	Messrs. E. L. Armstrong and W. B. Alexander	£230 for compilation of data
23. Substitutes for Tin Plate	9th October, 1917	Professor Masson (Chairman), Dr. H. Green, Messrs. R. J. Lewis and G. Ampt	£50 and £100 from Department of Defence for salary of assistant and expenses
24. Utilization of Kelp	16th October, 1917	Messrs. C. H. Slayter (Chairman), L. Rodway, D. H. Avery, and P. J. McLeod	£250 for working expenses
25. Blow-fly Pest in Queensland	13th November, 1917	Messrs. S. P. Fraser (Chairman), W. G. Brown, A. H. Cory, and J. B. Henderson	£500 to supplement grant by Queensland State Government
26. Cold Storage Problems ..	11th December, 1917	Messrs. R. Crowe (Chairman), W. J. Williams, and F. W. Veat	Nil

(a) See Bulletin No. 4, "The Factors Influencing Gold Deposition in the Bendigo Gold-field."—(b) See Bulletin No. 1, "The Cattle Tick in Australia."—(c) See Bulletin No. 3, "The Alunite Deposits of Australia and their Utilization."—(d) See Bulletin No. 2, "Worm-nodules in Cattle."—(e) See Bulletin No. 5, "Wheat Storage Problems (Damaged Grain and Insect Pests)."—(f) See Bulletin No. 6, "Power Alcohol: Proposals for its Production and Utilization in Australia."

Particulars of Special Committees appointed up to the 30th June, 1918—continued.

Subject.	Date of Appointment.	Personnel.	Grants made during Financial Year, 1917-18
27. Tuberculosis in Stock— (i) New South Wales Committee	18th December, 1917	Professor J. D. Stewart (Chairman), Messrs. A. Barnett, R. C. Bell, J. T. Cole, Dr. S. Dodd, Messrs. J. C. McEachran, J. A. Robertson, S. T. D. Symons, and Hon. J. C. White	£25 for clerical assistance
(ii) Victorian Committee	.. ..	Professor Woodruff (Chairman), Messrs. W. C. Angliess, E. F. J. Bordeaux, Dr. S. Cameron, Messrs. W. C. Greaves, J. Hancock, J. Robertson, W. A. N. Robertson, and P. Tuckett	Nil
(iii) South Australian Committee	.. ..	Messrs. L. B. Ball, D. Forbes, C. A. Loxton, F. E. Place, and T. H. Williams	Nil
(iv) Western Australian Committee	.. ..	Dr. E. Atkinson (Chairman), Messrs. E. Brown, G. A. Greenhill, G. S. Harvey, A. Watson, and R. G. Weir	£25 for clerical assistance
(v) Tasmanian Committee	.. ..	Messrs. J. C. Newton, M.H.A. (Chairman), A. Conlon, R. C. Field, T. Philp, and Propsting	£100 for travelling and other expenses
28. Nitrogen Requirements of Australia	26th March, 1918	Mr. W. R. Grimwade (Chairman), Dr. F. H. Campbell, and Mr. G. Lightfoot	Nil
29. Bye-products of Wool Scouring	28th March, 1918	Messrs. P. Whitteron (Chairman), R. J. Fletcher, and T. Welsh	Nil
30. Utilization of Clays in Western Australia	10th June, 1918	Messrs. C. S. Nathan (Chairman), A. Gibb-Maitland, and E. S. Simpson	£300 for salary of assistant and expenses subject to contribution of equal sum by W.A. State Government

3. Standing Committees.—Up to the 30th June, 1918, the Executive Committee had appointed five Standing Committees, as follow :—

PARTICULARS OF STANDING COMMITTEES APPOINTED UP TO THE 30th JUNE, 1918.

Subject.	Date of Appointment.	Personnel.	Grants made during Financial Year 1917-18.
1. Chemicals	30th May, 1916	Professor Masson (Chairman), Dr. F. H. Campbell, and Messrs. V. G. Anderson, W. R. Grimwade, E. A. Mann, and Dr. Heber Green (Secretary)	£26 for remuneration of Secretary
2. Marine Biological Economics of Tropical Australia	18th November, 1916	Messrs. C. Hedley (Chairman), E. J. Banfield, Professor Dakin, Dr. T. H. Johnston, and Mr. A. R. McCulloch	£15 for expenses in connexion with investigation into life-history of trochus £300 for investigations of sponge-beds near Cooktown
3. Metric System and Decimal Coinage	21st August, 1916	Professor Ross (Chairman), and Mr. F. W. Barford	Nil
4. Seed Improvement ..	16th November, 1917	Professor Ewart (Chairman), Messrs. F. F. Coleman, H. M. Nicholls, Professor A. J. Perkins, Messrs J. F. Pridham, H. Pye, A. E. V. Richardson, G. L. Sutton, and H. Wenholz	£250 for salary of Secretary and £50 expenses
5. Native Grasses and Fodder Plants	18th December, 1917	Mr. E. Breakwell (Chairman), Professor Ewart, and Messrs. A. E. V. Richardson, W. J. Spafford, G. L. Sutton, and C. T. White	Nil

4. Other Committees.—In addition to the Special and Standing Committees appointed solely by the Executive, grants have been made or representatives have been appointed by the Executive to certain other Committees and organizations. The action taken by the Executive in this direction is summarized in the following statement :—

OTHER COMMITTEES AND ORGANIZATIONS ASSISTED BY EXECUTIVE COMMITTEE, 1917-18.

Name of Organization.	Grant during Financial Year, 1917-18.	Particulars.
1. Society of Chemical Industry of Victoria	£ 50	Grant made for incidental expenses on standardization of chemical analyses
2. New South Wales Pastoral Committee for Investigation of Blow-fly Pest	500	Professor J. D. Stewart represents the Executive Committee on the Pastoral Committee. Grant is made to supplement funds available from New South Wales State Government
3. Electrical Association of Australia : Committee on Standardization	Nil	Professor T. R. Lyle and Mr. F. Leverrier, K.C., represent the Executive on the Victorian and New South Wales sections of the Committee respectively
4. Commonwealth Flax Industry Committee	Nil	Committee appointed by Regulations under the War Precautions Act on the recommendation of the Executive, which is represented by Mr. T. Hogg
5. Naval Board	Nil	Professors Masson and Lyle, Major A. J. Gibson, and Mr. W. R. Grimwade were appointed by the Executive as a Committee to advise on certain confidential matters.

5. Conferences.—During the financial year two Inter-State Conferences were convened by the Commonwealth Government on the recommendation of the Executive Committee. These were the Conference of Agricultural Scientists held at Melbourne in November, 1917, at which the Advisory Council and each of the States were represented, and the Conference which met at Brisbane in February, 1918, to devise a scheme for a co-operative campaign for the repression of the cattle-tick pest. At the latter Conference, representatives were present from the Advisory Council, the Commonwealth Quarantine Department, and the States of New South Wales and Queensland. In addition, the Executive Committee was represented at the Inter-State Forests Conference held at Perth in November, 1917, and at the National Roads Convention held at Sydney in July, 1918. The following tabular statement gives particulars of these Conferences:—

PARTICULARS OF CONFERENCES, 1917-18.

Conference.	Date.	Grant by Advisory Council	Representatives.
1. Agricultural Scientists (a)	9th to 16th November, 1917	£ 290	Professor A. J. Perkins (Chairman), Messrs E. Breakwell, H. T. Easterby, Professor T. T. Flynn, Dr. W. H. Green, Messrs. W. R. Grimwade, T. Hogg, D. McAlpine, Professor J. W. Paterson, Messrs. J. T. Pridham, H. Pye, H. C. Quodling, A. E. V. Richardson, T. A. J. Smith, G. L. Sutton, Professor R. D. Watt, Messrs. H. Wenzholz, and W. B. Alexander (Secretary)
2. Inter-State Forestry ..	November, 1917 ..	Nil	Advisory Council represented by Mr. E. A. Mann
3. Tick Pest ..	February, 1918 ..	Nil	Professor J. D. Stewart (Chairman), Messrs. G. E. Bunning, A. H. Cory, P. Cowley, Dr. J. H. L. Cumpston, Mr. S. T. D. Symons, Professor H. A. Woodruff, and Mr. W. B. Alexander (Secretary)
4. National Roads Convention	11th July, 1918 ..	Nil	Advisory Council represented by Mr. G. Lightfoot

(a) See Bulletin No. 7, "Agricultural Research in Australia."

6. General Progress of Investigational Work.—As will appear from the more detailed information furnished hereinafter regarding the various investigations initiated and undertaken by the Executive Committee, considerable progress has been made in the work of many of the above Committees, some of which have already completed their investigations.

As regards the Committees on the tick-pest and the nodule disease in cattle, full reports have been received by the Executive based on the information available as the result of the various investigations already carried out by other authorities. Lines of further action for the repression of the tick-pest have been formulated by the Conference which met in Brisbane in February, 1918. A scheme has also been prepared for eradicating the prickly-pear pest by co-operative action by the Commonwealth and the State Governments of New South Wales and Queensland. The Executive is of the opinion that the establishment of any general comprehensive scheme for the control and repression of parasites and diseases of live-stock and of crops or for the eradication of weed-pests is too large and complex a matter to be dealt with efficiently by the existing temporary organization with its limited financial resources and executive powers. Moreover, any scheme for the control of these pests can be carried out by the Commonwealth Government only with the co-operation of State authorities, so that agreement must be reached as to the relations between the various authorities before any comprehensive lines for action can be adopted. So far as practicable, the Executive Committee has, however, arranged for further necessary investigational work to be carried out in connexion with some of the more important of these problems. Thus the Special Committee on the means of transmission of the worm-nodule parasite is conducting fundamental investigations into matters that must be cleared up before any scheme for control can be devised. Similarly, in regard to the tick-pest, an investigation into the life history of the cattle-tick is being conducted in Queensland, and will be completed by about April, 1919.

It will be found in a later part of this Report that the above remarks apply equally to certain large problems to which the Executive Committee has given full consideration, but for which it has not thought it desirable to appoint Special Committees. For example, the whole question of the utilization of forest products involves issues that are too large and complex to enable the existing temporary organization to deal with it in the comprehensive manner which its importance and magnitude demand. Though it would probably have been practicable for the Executive Committee to tackle one or more of these large problems on a limited scale in particular States, the Committee holds the view that they are essentially problems that should be viewed from a Federal stand-point, and dealt with, as far as practicable, on a co-operative Inter-State basis.

It should be pointed out that in addition to the investigational work carried out by Special and Standing Committees, there is a considerable number of other matters of high importance under consideration which have not yet reached the stage at which they can be referred for systematic work by Committees of experts, or which cannot be dealt with adequately until the permanent Institute is established.

Further, a large number of inquiries of a varied nature have been received by the Executive Committee. Some of these have reached finality, others are still receiving attention. They have arisen largely through inquiries made by persons engaged in industries for advice on scientific and technical matters and by inventors or discoverers of new processes or raw materials. At present they fall into no considered plan, but it is probable that many of those which are still receiving attention will find their place later in some co-ordinated scheme of work under the permanent Institute. With the staff and funds at the disposal of the temporary organization it has not been practicable to undertake experimental work on a number of matters which have been brought before the Executive Committee. If the Advisory Council had laboratories of its own, or if the permanent Institute had been established, the work would have been greatly facilitated and could have been made more effective. The absence of any such laboratories has, moreover, seriously impeded the progress of the work of certain of the Special Committees. Under existing conditions the whole of the experimental work has been carried out for another year through the courtesy of various authorities and persons in control of existing laboratories in different parts of the Commonwealth and under the guidance of scientific and industrial experts who have rendered their services to the Commonwealth gratuitously.

PART IV.—INVESTIGATIONAL WORK.

A.—AGRICULTURAL AND PASTORAL INDUSTRIES.

1. Inter-State Conference of Agricultural Scientists.—In November, 1917, an Inter-State Conference of Agricultural Scientists was held in Melbourne. This Conference was convened by the Commonwealth Government on the recommendation of the Advisory Council and with the approval of the Ministers of Agriculture of all the States, and was the first Conference of the kind held since Federation.

The representatives of the various States were as follow :—

New South Wales.—Professor R. D. Watt, Professor of Agriculture in the University of Sydney ; H. Wenholz, Inspector of Agriculture ; E. Breakwell, Agrostologist.

Victoria.—Dr. W. Heber Green, Lecturer in Agricultural Chemistry in the University of Melbourne ; A. E. V. Richardson, Superintendent of Agriculture ; H. Pye, Cerealists ; D. McAlpine, Mycologist.

Queensland.—H. C. Quodling, Director of Agriculture ; H. T. Easterby, General Superintendent of the Bureau of Sugar Experiment Stations.

South Australia.—Professor A. J. Perkins, Director of Agriculture.

Western Australia.—Professor J. W. Paterson, Professor of Agriculture in the University of Western Australia ; G. L. Sutton, Commissioner for the Wheat Belt.

Tasmania.—Professor T. T. Flynn, Professor of Biology in the University of Tasmania.

In addition, papers on special subjects were contributed by the following :—Mr. T. Hogg, on Fibre-plants ; Mr. Temple A. J. Smith, on Tobacco ; and Mr. W. R. Grimwade, on Crops for the Production of Power Alcohol.

In welcoming the delegates to the Conference, Professor Masson spoke as follows :—

“ The Executive hopes that this Conference will do two things—perhaps I should say three. You will consult with one another as to the past and present state of knowledge in respect of those important subjects which are on the programme. You will consult with one another as to the best future scheme of work and the best method of insuring that that work shall be shared, and shared fairly, among the different workers of Australia. Thirdly, you will be able to offer to the Executive Committee some advice as to ways in which the Federal Government, operating through the Advisory Council, can help the progress of scientific agricultural research in Australia without producing harmful results by interference, but by helping the State activities and the work of all those who are engaged in such research. I need hardly say that all resolutions which are passed by the Conference and forwarded to the Executive Committee will receive the very fullest and most careful consideration. It may not be in the Committee's power to help in all the ways which you may suggest, as our financial powers are limited, but all the recommendations you make will be very carefully considered, and the Executive will be glad to call the attention of the Prime Minister and the Government to any practical steps which seem to be pointed to as the result of this Conference.”

Those resolutions of the Conference which recommended means of assisting or stimulating the cultivation of particular crops are dealt with in the following sections, and the action taken in regard to each of them is there detailed.

The general question of the relation of the Commonwealth to agricultural research occupied the Conference on the concluding day of its deliberations. The question was introduced by a paper by Professor A. J. Perkins, entitled "Some Suggestions as to the Commonwealth Endowment of Agricultural Research," and by an address by Professor R. D. Watt on "Agricultural Research and the Prevention of Overlapping." An important discussion followed, a *résumé* of which, together with the two papers referred to, will be found in Bulletin 7 of the Advisory Council which contains all the papers read at the Conference and a Report of its proceedings. As a result of suggestions made in the course of the discussions of the Conference, the following general resolutions were carried :—

- (a) That this Conference recommends that each State Department of Agriculture should continue or initiate the work of improvement and selection of its cultivated crops as part of its regular work, and that such work of improvement be on uniform lines in all the States.
- (b) That the Executive Committee of the Advisory Council be asked to arrange for an annual meeting of Plant-breeders from the different States with a view to co-ordinating their work, and arriving at a uniform policy without interfering with individual methods. The meeting to be fixed at a convenient season of the year (July).
- (c) That in view of the need for a supply of scientific investigators into agricultural and pastoral problems the Advisory Council of Science and Industry be requested to direct the attention of the various Australian Universities to the subject.
- (d) In view of the prominent position occupied by the United States of America in scientific and practical agriculture and of the similarity of the climatic and economic conditions of that country to those of Australia, this Conference recommends the early appointment of a permanent agricultural representative from Australia to the United States, whose duties should include keeping Australia in touch with improved scientific and practical methods in agriculture and the supply of promising varieties of cereals and other crops.

On these four resolutions the Executive Committee has taken action as follows:—Resolution (a) was forwarded to the Department of Agriculture in each State. Resolution (b) was referred to the Seed Improvement Committee (see p. 23) for advice as to the calling of future Conferences. Resolution (c) was forwarded to each of the State Governments and each of the Australian Universities. Resolution (d) was forwarded to the Commonwealth Government with the suggestion that, as it was understood that it was proposed shortly to appoint an official representative of Australia in the United States, a thoroughly qualified agricultural expert should be attached to his staff.

2. The Control and Eradication of Pests and Diseases of Stock and of Crops.—

The loss caused, directly and indirectly, to the agricultural and pastoral industries of Australia, and the secondary industries dependent on them, by the attacks of pests, parasites, and organisms causing disease amounts to millions of pounds per annum. Nearly all the most serious pests in Australia have been introduced from other countries, and it is therefore probable that the introduction of many of them could have been prevented by rigid measures of quarantine. Such pests as were introduced in spite of the quarantine could probably have been easily exterminated if they had been attacked in a scientific manner as soon as their presence and injurious nature were notified in any locality. Now that many of them have become diffused over the whole or a great part of Australia, the work of eradication would be costly and take a number of years, but there is little doubt that properly organized campaigns conducted with the active assistance of the industries concerned would ultimately be successful. Before an efficient campaign against any of these pests can be organized, however, it is necessary that the life-histories of the pests and the methods by which the parasites are transmitted from one host to another should be fully understood.

Of the pests and diseases injurious to stock in Australia the principal are the cattle-tick, the worm (*Onchocerca gibsoni*) which produces nodules in beef, the sheep blow-fly, and the tubercle bacillus. As a result of their preliminary inquiries, the Committee learnt that the cattle-tick and the nodule-worm had engaged the attention of numerous workers, and that various papers on different aspects of the subject had been published. It was therefore decided to appoint Special Committees to review the results of past scientific work, to suggest what further work should be

undertaken, and to make recommendations as to the best means for the control and eradication of the parasites. These Committees met at Sydney in September, 1916, and their reports have been published in Bulletins 1 and 2 of the Advisory Council. The recommendations made by the Committee on **Cattle-tick** were of two kinds:

- (1) That further scientific investigations as to the life-history of the cattle-tick in Australia and as to the micro-organism, conveyed by the tick, which causes tick-fever should be carried out.
- (2) That the Federal Government should undertake the work of eradicating the pest, inaugurating a campaign by commencing in certain areas and gradually extending the field of operations, making every effort to secure the co-operation of the stock-owners.

The first series of recommendations, for further scientific investigations of the tick, were of a kind coming directly within the scope of the Advisory Council's activities, and a Special Committee was appointed in August, 1917, to undertake such investigations in Queensland, with a grant of £1,200 for a period of one year.

The members of the Special Committee are Mr. C. Booker, M.L.A. (Chairman); Mr. A. H. Cory, Chief Inspector of Stock; and Dr. T. H. Johnston, Lecturer in Biology, University of Queensland, who is in charge of the actual experimental work. Researches are being undertaken by Dr. Johnston and his assistants in three different localities in southern Queensland, with the object especially of ascertaining the effect of varying meteorological and climatic conditions on the life of the tick, though various other lines of investigation are also being pursued. A report on the work accomplished to the end of the financial year is given in smaller print in paragraph (i) below.

The second recommendation of the Committee, viz., that the Federal Government should undertake a campaign for eradication of the tick could not be acted upon by the Advisory Council itself, as it has not the necessary administrative powers. It therefore forwarded the recommendation to the Commonwealth Government with the suggestion that, if the Government agreed that it was desirable that the Commonwealth should intervene in the matter, it should ask the States specially concerned (New South Wales and Queensland) to affirm the desirability of Federal co-operation, and, as a first step, to appoint delegates to a Conference, at which a detailed scheme for a co-operative campaign could be drawn up. This action was taken by the Commonwealth Government, and the two States appointed delegates to a Conference with representatives of the Commonwealth, which was held in Brisbane in February, 1918. A *résumé* of the proceedings of the Conference, and of its recommendations, appears in paragraph (ii) below.

The recommendations have been indorsed by the Executive Committee and forwarded to the Commonwealth Government, which has printed them as a paper of the Commonwealth Parliament, and has forwarded a copy to the Premier of each State, asking for an expression of opinion as to the proposals. It seems most desirable that all those interested in the Australian cattle industry should unite to urge on the Governments concerned the desirability of putting the recommendations into force as early as possible.

The Committee on the **nodule-worm** reported that its mode of transmission from one host to another was still unknown, and that until this was discovered it would be impossible to suggest measures for dealing with the disease. Accordingly the Executive made a grant to a Special Committee consisting of Professors S. J. Johnston and J. D. Stewart and Dr. J. B. Cleland to enable them to carry out further researches on this point. As the result of its work the Committee believes that march-flies will be shown to be the carriers of the parasite, though this has not yet been completely demonstrated. A report on the work carried out to the end of the financial year will be found in paragraph (iii) below.

The subject of **tuberculosis in stock** was investigated by a sub-committee of the Queensland State Committee, and its report was published by the Queensland Government in 1917. The Executive subsequently decided that it was desirable to obtain reports on this subject from each of the States of the Commonwealth, and accordingly appointed a Special Committee in each of the other States. These Committees have been asked to report on the prevalence of the disease in the State, the sources of infection, the losses caused, and the preventive measures at present in operation, and to make recommendations as to any further action that they may consider desirable. When all these reports have been received and collated, the question as to what further action should be taken will be considered by the Executive Committee.

The Executive Committee has given much consideration to the best means of assisting investigations on the **sheep blow-fly** with a view to decreasing the ravages of the pest. A joint committee of the Pastoralists Association of New South Wales and the State Department

of Agriculture has conducted investigations on the subject in that State for some years, and has achieved valuable results, especially by the discovery of several natural parasites of blow-flies. The Executive has made a grant of £500 to this Committee to assist its operations, and appointed Professor J. D. Stewart to represent the Advisory Council on the Committee. In view of the different climatic conditions existing in Queensland, it seemed desirable to extend operations to that State also, and the Executive accordingly appointed a Special Committee in that State, consisting of Mr. S. P. Fraser (Chairman), Mr. A. H. Cory, Chief Inspector of Stock, Mr. W. G. Brown, Sheep Expert, and Mr. J. B. Henderson, Government Analyst, to continue investigations begun by the Department of Agriculture and Stock. A grant of £500 was made to this Committee to supplement a similar amount made available by the Department, and the Committee was asked to keep in close touch with that in New South Wales to prevent unnecessary duplication of effort. The Committee has commenced comprehensive experiments on methods of dipping and spraying sheep and of trapping and poisoning blow-flies. Further information is given in paragraph (iv) below. Dr. Merrilees, of Roma, has kindly offered to assist in the work by investigating the cause of the fever which frequently accompanies blow-fly infestation, and appears in many instances to be the main cause of the mortality among fly-blown sheep.

On the recommendation of the Executive Committee, the Commonwealth Government requested Professor H. Maxwell Lefroy, who was in Australia as one of the British Wheat Commissioners, to remain on the completion of this work to undertake investigations on the blow-fly and other insect pests. Professor Lefroy was unwilling to undertake the work immediately, but an offer was made to him which he will consider, and it is hoped that he will be able to accept it after a short period in England, and will then return to Australia.

Previous to the arrival of the British Commission, the Executive had already, at the request of the British Government, appointed a Special Committee to investigate the **insect pests of stored grain**. The Committee recommended that investigations should be undertaken at a cost of £1,200 per annum, and that the Commonwealth Wheat Board should be asked to provide the necessary funds. The Wheat Board was unable to make a grant for this purpose, and, in view of the investigations which were undertaken by Professor Lefroy on behalf of the British Government as well as by some of the State Governments, it did not seem desirable to take further steps immediately. It appears that, for the immediate purpose of destroying weevils in the wheat at present in store, the method now being adopted of treating the weevilly wheat by heat is the best. But much research still remains to be done on the life-histories of the various pests and the best means of preventing infestation, and the Executive considers that such work should be systematically undertaken as soon as possible, even though results may not be reached in time to have any beneficial effect on the present situation. At present the Executive is awaiting Professor Lefroy's reply to the Commonwealth Government's offer before considering the matter further.

In July, 1917, the Executive Committee had an interview with Mr. A. O. Barrett, who outlined a scheme for the storage of wheat in special silos after mixing it with quicklime. The Executive Committee appointed additional members to the Special Committee to carry out tests of the effect of quicklime on damaged wheat on a larger scale, and accepted Mr. Barrett's offer to allow these experiments to be undertaken at his firm's maltings at Richmond.

The report of this Committee was published in full in Bulletin 3 of the Council. The experiments made pointed to the following conclusions:—

1. When wheat is treated with freshly-burnt quicklime under the conditions suggested by Mr. Barrett, the bacteria on the outer layers of the grains are considerably reduced in numbers, and the surface is slightly corroded and cleansed from organic nitrogenous compounds. When wetted, the limed wheat turns distinctly yellow, although all the free lime is apparently removed by screening.
2. With *f.a.q. wheat* the effect is to facilitate the process of tempering and to improve the quality of the bread baked from the flour. No harmful effect has been observed or is to be expected.
3. *Weevils* in the insect stage are not at once killed by cold lime, nor does it prevent the egg from hatching out.
4. *Damaged wheat* is not rendered wholesome if the corns are rotted throughout, but further deterioration is checked. This is due to removal of rubbish and partial sterilization of the surface of grains.
5. From *mousey-tainted wheat* the taint is removed, and, where the grain is not otherwise deteriorated, eatable bread can be made from the flour.
6. It is very important that the lime used shall be freshly ignited and hot, and not partially slaked.

7. An effective indication of the contamination or deterioration of wheat is afforded by the ammonium content of the extract obtained by soaking the wheat in water. Thus the damaged samples examined were found to yield from eight to fifteen times as much ammonia as the clean wheats.

One of the resolutions passed at the Inter-State Conference of Agricultural Scientists was a recommendation "that the **rust in cereals**, particularly black rust in wheat, which is common in all the States and in some seasons largely reduces the yields, be made the subject of a special investigation in connexion with plant-breeding." This matter has been referred by the Executive to the Seed Improvement Committee for suggestions as to the best means of carrying it out.

The attention of the Executive was drawn to the probability that the completion of the Transcontinental Railway was likely to result in the spread of **sparrows** and possibly, also, of starlings, to Western Australia, in which State they are not at present found. As a result of inquiries, this probability was strengthened, as it was discovered that sparrows had already travelled some distance westward along the line.

Captain S. A. White, of Adelaide, past president of the Royal Australasian Ornithologists Union, offered his services to the Committee gratuitously to investigate the matter, provided the Federal authorities would give him the necessary facilities for travelling on the railway. This was arranged, and Captain White made several journeys along the line, and investigated reported occurrences of these birds at various points. As a result, he reached the conclusion that at present sparrows have not got beyond Tarcoola, and arrangements were therefore made with residents at that township to destroy the birds. It is hoped that they will shortly be eradicated in that locality. In the meantime it was learnt that the sparrows were also travelling along the coast, and that on two occasions parties of three and four respectively had been seen at Eucla, and that they had also occurred 90 miles further west in Western Australia. It appears probable that these birds were destroyed by hawks, but steps are being taken to destroy any further sparrows that may reach Eucla.

(i) *Investigations on the Life-history of the Cattle-tick.*—In August, 1917, the Advisory Council of Science and Industry decided to carry out investigations regarding the biology of the cattle-tick (*Boophilus australis*) with a view to determining the length of time taken by the tick to pass through its different stages—especially the egg and larval periods—in different localities and under different conditions. A comprehensive scheme of work was outlined by Dr. T. Harvey Johnston, University, Brisbane, to whom the work was intrusted. This was adopted by the Executive, who requested that preference should be given to certain items in the scheme outlined, viz. :—

- (1) The period elapsing between the dropping of the engorged female and the commencement of egg-laying ; and the period during which egg-laying continues.
- (2) The number of eggs laid ; the time taken to hatch, and the percentage which hatch out, under various climatic conditions.
- (3) Results of various external conditions on the life of the larva, and vitality of larva after prolonged starvation, &c.
- (4) Biology of cattle-ticks matured on animals other than cattle, to determine fertility.

The relationship of the desired data to the question of quarantine will be readily recognised, since answers to these problems would furnish the facts on which a reasonable period of quarantine could be based, such period varying no doubt according to the time of the year and, perhaps, also according to certain climatic conditions.

A Special Committee, consisting of Messrs. C. J. Booker, M.L.A. (Chairman), and A. H. Cory, M.R.C.V.S. (Chief Inspector of Stock, Queensland), and Dr. Johnston, was appointed to supervise the investigations, the actual scientific part of the work being, however, placed under the control of the last-named. Operations commenced on the 1st October, 1917.

Four stations have been established, viz. :—At the University, Brisbane, as head-quarters ; Woolooga (a pastoral centre situated in the Wide Bay and Burnett district) ; Toowoomba (Darling Downs) ; and West Burleigh (a coastal centre, as a type of the coastal dairying districts of Southern Queensland and northern New South Wales). Only three were provided for in the original plan, but the generosity of Mr. Booker permitted the establishment of a fourth station. At each of these centres there is a trained scientific observer in charge, viz., Miss M. J. Walker, B.Sc. (Woolooga) ; Miss E. F. Peberdy, B.Sc. (Toowoomba) ; Miss G. Y. James, B.Sc. (West Burleigh) ; while at head-quarters Dr. Johnston is assisted by Mr. M. J. Colclough. At each station atmospheric and ground temperatures and also humidity are recorded daily. The work is being carried out on the same lines at all stations, and as large numbers of ticks as possible are being used so that the results outlined may be more valuable. Every engorged female received is numbered, its date of dropping or removal from the animal noted, and the period before egg-laying begins and that during which egg-laying takes place are both carefully recorded, also the hatching period, the dates on which larvæ begin to die off, and the earliest date on which all the larvæ of a brood are dead. No food is supplied. These experiments are carried out in tubes in the open in shade, while a number of ticks are regularly placed in small grass plots under natural conditions, and the same periods noted as far as possible. Thus it is hoped to ascertain the various periods (maximum, minimum, and average) of the non-parasitic stages in the tick life-cycle, and particularly to determine the maximum and minimum periods of time between the dropping of the engorged female tick and the death of its larvæ which do not have access to a suitable host.

The information relating to the various stages of its life-history is being compiled and compared with the climatological data in order to ascertain what relationship, if any, exists between these periods and the temperature or humidity. A selected number of ticks are being regularly observed to ascertain the number of eggs laid and the percentage which hatch out. The result of immersion in water of eggs, larvæ, and engorged ticks for varying periods of time is also being noted, as we know that ticks may be distributed by flood waters.

The detrimental effect of cold weather and of dry conditions on the development of the non-parasitic stages of the cattle-tick has been proved. The former rapidly kills off the larvæ, and retards and even prevents the laying and hatching of eggs, thereby lengthening the period during which a paddock would remain infected. Continued dry weather retards development, and eventually may kill the eggs and larvæ. The influence of moisture and warmth on tick life have been shown to be very marked, as the non-parasitic stages are passed through much more readily than when these two factors are less favorable. The periods have been found to vary according to the time of the year.

Acknowledgment is made of the assistance given by the University Senate for the use of laboratory, library, and equipment; the Chief Secretary's Department, which granted concessions in the way of railway travelling; Mr. C. J. Booker, of Woolooga, for his assistance in establishing one of the stations; Mr. A. H. Cory (Chief Inspector of Stock, Queensland) and certain of his Stock Inspectors; and the Commonwealth Meteorologist for the loan of certain apparatus. The hearty co-operation of the officers at the various stations is gratefully acknowledged by Dr. Johnston. A full account of the investigation will be published when it is complete.

(ii) *Résumé of Proceedings at Conference called to draw up a Scheme for Repression of the Cattle-tick by co-operation between the Commonwealth and State Governments.*—The delegates of New South Wales and Queensland placed before the Conference particulars of certain changes in the situation which had taken place since the meeting of the Committee in Sydney eighteen months previously. The chief modifications were that New South Wales had started compulsory continuous dipping in the Tweed River Quarantine Area, and that the Queensland Government had appointed an Advisory Board to assist the Stock Department in its control of tick, and had voted a special subsidy for the work of the Board. In the opinion of the majority of the members of the Conference these changes did not diminish the importance of Federal co-operation with the States in tick eradication, but the Queensland delegates stated that in their opinion this was no longer desirable, though they had recommended it eighteen months before. They thought that the new Queensland Board was doing all that was necessary in that State, and they stated that Queensland's experience of Federal intervention in connexion with other matters had led them to modify their opinions as to its desirability in tick eradication.

After prolonged discussion, the Queensland delegates finally withdrew from the Conference, on the ground that they dissented from the principle of Commonwealth intervention or co-operation in any form other than mere financial assistance, whereas the remaining delegates insisted that the reasons which had led the previous Committee to urge Federal intervention were just as cogent as they had been eighteen months before. The chief of these reasons are—

- (a) That the losses due to the tick, though falling primarily on Queensland and the Northern Territory, and, to a less extent, on Western Australia and New South Wales, affect all the States to a considerable extent, owing to the ramifications of commerce.
- (b) That unless the spread of the tick is checked, there is every probability that all the States will ultimately become infested.
- (c) That all past efforts to obtain concerted action by affected States have failed.
- (d) That eradication can only be achieved by the continuous systematic application of effective methods, complete organization, and central direction or control.
- (e) That effective methods will involve expenditure of sums greater than those hitherto allocated for this purpose by the State Governments.
- (f) That the full success of any scheme for tick eradication is impossible without the active co-operation of stock-owners and interested persons. That many who are now apathetic would support action for the eradication of the pest if they felt convinced that their herds would not be exposed to subsequent infestation, and that the guarantee that would be given by a central control removed from purely local influences would be of great value in this connexion.

Under the *Commonwealth Quarantine Act* 1908–1915, the Commonwealth Government has full power to take action for the control of stock diseases in any part of Australia, either with or without the assent and co-operation of the State or States concerned, but, though this is the case, the Conference considered that there would be no prospect of success in a Federal campaign against the tick unless the States, local authorities, and stock-owners were prepared to co-operate.

It was therefore recommended that in certain areas a system of partial co-operation should be inaugurated, the Commonwealth giving a financial subsidy to the State concerned to assist it in its efforts in those areas, with occasional inspection by a Commonwealth officer for the purpose of ascertaining that the expenditure of the money provided is calculated to promote the object in view. It was recommended that an area in the south-east of Queensland, south of the Burnett River, should be dealt with in this manner, and that the Director of Quarantine should discuss with the Chief Inspector of Stock in Western Australia the advisability of adopting the same method in one or more areas of that State.

It was further recommended that in the tick-infested area of north-eastern New South Wales, and an adjacent strip of Queensland, complete co-operation should be adopted, the legislative and administrative machinery of both the Commonwealth and the States being brought into force, and the Commonwealth providing £1 for every £1 spent by the States on tick eradication in that area. It was thought that a concentrated effort in this area would demonstrate the possibility of complete eradication of the tick, and would at the same time exterminate the pest from New South Wales, and remove the menace that has been threatening the cattle industry in that State for a number of years.

It was recommended that the details of the campaign in this area should be settled by consultation between the Director of Quarantine and the Chief Inspectors of Stock of the States, and that the existing State field officers and existing dips should be used as far as possible.

(iii) *Progress Report of the Work of the Special Committee on the Worm-nodule Parasite.*—The work of the Special Committee on the Worm-nodule Parasite was begun at Kendall, on the Camden Haven River, on 6th January, 1917. The dairy herds in the district were examined and found to be heavily infested with worm-nests. The aim of the Committee was first to discover the life-history of the worm. It was assumed that the worm might pass through a larval stage in an intermediate host such as a march-fly, mosquito, cattle louse, or fresh-water crustacean; or it might possibly have no intermediate host, but spend some time of its larval period free-living in moist soil. Accordingly the position in which infected cows were lying at night was noted, and next morning the soil in contact with their chests was dug up and examined microscopically for larvæ of *Onchocerca*. Many nematode worms were found but no *Onchocerca*.

Mosquitoes, march-flies, lice, and fresh-water Crustacea were also examined microscopically. Only a few lice were found, but many of the others were collected and examined. Some thousands of the Crustacea, embracing about 35 species, were examined microscopically, but no trace of the worm-larvæ found.

Many mosquitoes were also examined without success. During the summer of 1917, nearly 3,000 march-flies were dissected and examined for larvæ. Thirty species of flies were represented in this number, and in one of them, *Tabanus circumdatus*, a larval worm was found in the crop; 230 specimens of this species were represented.

Experiments were carried out to try to infect Crustacea and flies with the larval worms taken from worm-nests of freshly-killed cattle. No larvæ ever became established in the Crustacea, but they were frequently found in the flies belonging to the species *T. circumdatus*, which had been fed on fruit over the surface of which living worm-larvæ had been spread. Though the summer of 1918 was very wet and unfavorable for the work, over 4,000 march-flies, embracing 40 species, were collected. Larval worms were found twice in *T. circumdatus* and once in an undescribed species of *Tabanus* closely related to *T. circumdatus*. A study of the life-history of the latter fly has been begun.

A number of experiments with calves have been started and are being continued which should afford valuable evidence as to the means of infection.

Besides the dairy-herds in the district round Kendall others were examined in the North Coast, as far as Lismore and Murwillumbah; in New England; in the South Coast; the Southern Tablelands; and in Riverina. Worm-nests were found in all districts, but very few in New England, and comparatively few in the Southern Tablelands and in Riverina.

(iv) *Progress Report of Work of Queensland Blow-fly Committee.*—The work of the Special Blow-fly Committee was commenced in February, 1918, at Dalmally Station, Roma, by the kind consent of Mr. W. A. Russell, the owner of the station, who has thus rendered the Committee valuable assistance. Mr. C. J. Hare was appointed to take charge of the experiments on the sheep under the direction of Mr. W. G. Brown (State Sheep Expert), a member of the Special Committee.

It was decided that experiments should be carried out on the following lines:—

- (a) The use of poisonous dips, as dips wetting the whole body of the sheep.
- (b) The application of poisonous dips in the form of a strong jet directed on the breach of the animal treated.
- (c) The use of other likely dressings applied only on the breach parts of the sheep.
- (d) The application of arsenite of soda alone in a comparatively strong solution by the method of jetting and dipping.
- (e) The trying out of the effect of merely cleansing material, such as soap and water, in the form of a washing solution instead of a dip mixture with poisonous dips.
- (f) The endeavour by means of traps or poisonous baits so to reduce the numbers of the fly as to restore normal conditions and thus protect the sheep.

Observations have been made that mice, of which there is at present a plague in the district, greedily take all kinds of pupæ in any stage of development. They also consume large quantities of maggots.

Mr. C. J. Hare reports to the Committee fortnightly on the progress of the operations which are taking place. In his latest report he stated that the experiments are progressing satisfactorily. Although flies were exceedingly numerous on the station in June, 1918, very few sheep were being struck. This unusual condition is also being noted in all sheep districts in Queensland. No reason can be given for the present immunity.

3. The Control and Eradication of Weed Pests.—It is impossible to estimate the loss caused to Australia by various introduced plants which have established themselves in this continent, and in some cases occupied large tracts of country. Of the hundreds of weeds which have been recorded from the different States, almost all are aliens. Almost the only native plants which come under this category are the bracken-fern and the various poison-plants. The introduction of weed-seeds with imported grain is inevitable, though adequate inspection reduces the danger from this source to a minimum, but many of our worst pests are plants which have escaped from cultivation in gardens, and it is obvious that useful or ornamental plants cannot be excluded from Australia on the ground that they might at some future date become pests.

At the present time, when a new weed is notified in any district, the Department of Agriculture of the State gives advice as to the methods by which it is most likely to be eradicated, and it is the business of the individual on whose land the pest has appeared, or of the District Council or other local body, to take means to deal with the weed if they see fit. If the weed appears on Crown land or along the roadsides it is usually neglected altogether, with the result that a plant which might easily have been stamped out if proper means to control it had been taken at the outset becomes a menace to agriculture over a large district, and the values of all land in the district are depreciated.

In considering the problem of the eradication of some of our weed-pests, the Executive have had various suggestions for the utilization of these plants placed before them, but have come to the conclusion that, though this consideration should not be neglected, its chief importance lies in the possibility that the industrial utilization of some products of a plant-pest may serve to lessen the cost of eradication. The proper course of action is to aim primarily at control and eradication, industrial utilization being an important, but a secondary, consideration.

The most serious weed-pest in Australia is the **Prickly Pear** (*Opuntia inermis*), which occupies some 20 million acres of land in Queensland, and 2½ million acres in New South Wales, and is estimated to be spreading in Queensland at the rate of a million acres a year. The Executive Committee, after informing itself fully of the research work on methods of eradication carried out in Queensland by the State Government's Board of Advice on Prickly Pear Eradication, and in

New South Wales by the Department of Agriculture, drew up a Report on the subject, with recommendations as to further work. This Report was presented to the Commonwealth Government in December, 1916, and was printed in the Report of the Executive Committee for the period to the 30th June, 1917, p. 20. The chief recommendations were—

- (1) That investigations should be carried out as to the suitability of insects and fungi known to be inimical to prickly-pear for acclimatisation in Australia, as to the methods of action of such insects or fungi on the pear, and as to such other matters as may arise in connexion with any biological or chemical researches found necessary.
- (2) That the sum of £8,000 per annum for a period of five years should be made available for this work, of which sum £4,000 should be contributed by the Commonwealth Government, and £2,000 each by the Governments of New South Wales and Queensland.

The Commonwealth Government has agreed to provide the £4,000 specified, and negotiations with the State Governments as to the provision of £2,000 each are still in progress.

A comprehensive Bulletin dealing with the prickly-pear, discussing the various attempts that have been made to utilize it commercially, and outlining the various methods of eradication, is in course of preparation.

Another weed which threatens to become a very serious pest in the temperate parts of Australia is the **St. John's Wort** (*Hypericum perforatum*). Starting from Bright, in Victoria, the plant has been carried in various directions by stock, and it is estimated that 184,000 acres are now occupied by it in Victoria, whilst it has also appeared in various localities in South Australia and New South Wales. Experiments conducted some years ago on behalf of the Victorian Department of Agriculture indicated that the best method of treatment was to cover the land with salt, but no treatment of this nature is applicable to the hilly country, which forms the stronghold of the plant, and from which it constantly spreads on to the cultivated land in the valleys. The Committee came to the conclusion that a possible solution of the problem would be the introduction of some insect which would feed only on St. John's Wort, and they have received from England, through the kindness of Professor E. B. Poulton, F.R.S., of Oxford, and Mr. J. C. F. Fryer, Entomologist to the Department of Agriculture, a list of such insects, prepared by Commander J. J. Walker, R.N. The most promising appears to be the St. John's Wort Beetle, *Chrysomela hyperici*, but further evidence is required as to the damage caused by this beetle to its host plant. The Executive discussed this question with Professor H. Maxwell Lefroy, who is a member of the Committee of the Imperial Entomological Bureau, and he kindly promised to look into the matter on his return to England, with a view to making arrangements for collecting insects for experiments either there or in Australia. According to present information, the liberation of the beetle in Australia would not involve any risk to crops, but this will, of course, require to be proved definitely by properly designed experiments.

4. The Cultivation of New or Improved Crops.—The Executive Committee has received numerous suggestion as to the desirability of cultivating in Australia crops which produce raw materials at present imported or whose products are imported. In connexion with these proposals it has been necessary to consider the reasons why these crops are not at present cultivated to any considerable extent in Australia, and in the cases of three of the most important, viz., Cotton, Flax, and Tobacco, it has been found that the main reason is economic and not climatic.

There seems no reason to doubt that **cotton** will grow as luxuriantly in northern Australia as in any other part of the world. Indeed, during the American Civil War a considerable quantity of high-grade cotton was produced in Queensland. In normal times, however, the high cost of picking cotton by hand is the main reason why Australia has been unable to compete with other countries where the cost of labour is much less. The most hopeful method of solving the problem is by the introduction of a mechanical picker which would obviate the necessity of hand-picking. A large number of machines for picking cotton has been patented in the United States of America, but it does not appear that any of these machines has proved really successful. The Committee has made inquiries from numerous sources in the United States, and has obtained a good deal of information on the subject. Several Australian inventors have devoted attention to the problem, and the Committee has received in confidence particulars of their inventions, which in no case are at present very complete. The difficulties in the way are great, but should not be insuperable. It is probable that they will be much reduced by the cultivation of varieties of cotton which, while not inferior in other respects, are specially adapted to mechanical picking. A large amount of work has already been done by the Special Committee in Brisbane, which was intrusted by the Executive with this investigation (see page 48).

The question of stimulating the cultivation of **fibre-plants**, especially **flax**, in Australia was one of the subjects discussed at the Agricultural Conference, and the following resolutions on the subject were carried :

- (a) That, in view of the high prices ruling for fibre products and the desirability of making Australia self-contained in the production of fibre, the Conference recommends the Advisory Council of Science and Industry to make a thorough investigation into the possibilities of fibre cultivation in Australia, particularly flax and sisal hemp, and the possibilities of producing these fibres for local manufacture or for export.
- (b) That the Advisory Council of Science and Industry be asked to ascertain whether the British Government would be prepared to purchase dew-retted flax fibre from Australia in 1919; and, if so, what quantities and at what price f.o.b.

The latter recommendation was immediately acted upon by the Executive Committee, and a reply was received from the British Government to the effect that it would be prepared to purchase all flax fibre produced in Australia at a price of £170 per ton delivered in England.

The Executive thereupon recommended to the Commonwealth Government that a Flax Industry Committee should be appointed by Regulations under the War Precautions Act to control and develop the industry. The Government appointed this Committee, on which Mr. T. Hogg represents the Advisory Council, and its efforts have led to a very considerable increase in the area of flax sown in Gippsland. Inquiries were made as to the possibility of obtaining seed from various sources in different States, but owing to the limited amount of seed available, and in view of the present lack of scutching mills elsewhere, it was thought best to confine cultivation mainly to Gippsland for the first season. Samples of seed have, however, been distributed to other localities for experimental purposes, and when reports from these localities have been received, the question of extending the cultivation of flax next season will be considered. Further details of the work of the Flax Industry Committee appear below. (See paragraph (i)).

The Agricultural Conference devoted most of its attention to the question of the improvement of the **cereal crops**, already so largely cultivated in Australia, especially wheat, maize, oats, and barley. Valuable papers on the breeding and improvement of these and other crops were read at the Conference, whose proceedings have been published as Bulletin 7 of the Advisory Council.

One of the resolutions of the Conference was as follows :—

“ This Conference recommends to the Executive Committee of the Advisory Council that a ‘ Seed Improvement Committee ’ be formed under the Council. This Committee should, among other matters, deal with—

- (a) The nomenclature of cultivated varieties of farm crops.
- (b) The elimination of undesirable varieties of crops.
- (c) The exchange and dissemination of seed samples for research work.
- (d) The recommendation of money grants to approved State or other institutions for work in connexion with seed improvement and the introduction of improved varieties of crops.”

The Executive has acted upon this resolution and formed a Seed Improvement Committee, consisting of representatives of all the State Departments of Agriculture, under the chairmanship of Professor A. J. Ewart. The Committee only recently commenced work, but a start has now been made on the work of preparing standard types of wheat. A provisional scheme for the classification of wheats has been drawn up, but its completion and detailed checking will need to be carried over probably two seasons to eliminate the possibility of annual variations in weak types.

The following resolution of the Agricultural Conference has been referred to the Seed Improvement Committee for advice as to any immediate steps that might be taken by the Executive to carry it into effect :—

“ That, in view of the benefits to be derived from the systematic introduction of seeds and plants into the Commonwealth, and to insure more economy of effort in this direction on the part of all the States, this Conference is of the opinion that as soon as practicable a Plant Introduction Bureau should be established, the functions of which would include :—

- (1) Arrangements for the introduction of new and useful agricultural plants from other countries into the Commonwealth.

- (2) The systematic testing of these introduced plants in co-operation with State Experiment Farms.
- (3) The systematic recording of the results of such tests."

The question of increasing the local production of **tobacco** was also considered by the Agricultural Conference, which recommended to the Executive Committee the advisability of closely investigating the tobacco industry in Australia, both in the interests of the producer and with a view to retaining locally the profits of manufacture. The Executive came to the conclusion that the chief drawbacks to the industry were of an economic and fiscal character, and not such as could be removed by scientific research. Moreover, the tobacco industry was investigated by a Royal Commission in 1904-5 6 and by the Inter-State Commission in 1915. Both these Commissions were impressed by the fact that, whilst there is plenty of land in Australia where good tobacco could be grown, the area under the crop is steadily decreasing, and both Commissions pointed out that the Australian tobacco industry is almost a monopoly of a single company. The Royal Commission recommended nationalization of the industry as the only remedy for this state of affairs.

In view of the foregoing facts the Executive has urged the Board of Trade to give consideration to the matter, with a view to finding some means of stimulating the production of tobacco in Australia.

Another vegetable product largely used in Australia for which we are dependent on other countries is **castor-oil**. The castor-oil plant grows freely in a wild state in many parts of Australia, and has actually been declared a noxious weed in certain localities. Yet all the oil manufactured in Australia is produced from castor-beans imported from India and Java. The Executive has collected a good deal of information as to the cultivation of castor-oil plants and the methods of harvesting the beans, and this has been published in the agricultural papers. Unfortunately, no local experience as to methods of culture best suited to Australian conditions or the most suitable varieties to cultivate appears to be available, but Messrs. Lycett are planting a trial area in Victoria to gain such experience, and the Executive is giving all the assistance in its power to this experiment. Castor-beans from plants growing wild have given yields of oil, under experimental conditions, only slightly lower than those of imported seed, and there seems no good reason why the cultivation of this crop should not be profitable at present prices. The main difficulty lies in the harvesting of the seed, which necessitates a good deal of labour, owing to the fact that it does not all ripen simultaneously.

The possibility of growing crops specially for the production of **industrial alcohol** was also discussed by the Agricultural Conference, which passed the following resolution on the subject:—

"The Conference is of opinion that the prospect of commercial production of power alcohol from certain crops is promising, and suggests that special experiments should be arranged by the Advisory Council of Science and Industry to determine the actual yields of alcohol obtainable from these crops, including sorghums in various stages of development."

This matter is in the hands of the Special Committee on Alcohol Fuel and Engines, whose activities are detailed on page 48.

Sugar crops were also discussed by the Conference, but as it appeared that researches in connexion with sugar-cane were undertaken in a most efficient manner by the Queensland Government, whilst the beet-sugar industry is entirely controlled by the Victorian Government, no assistance from the Advisory Council in regard to these crops was deemed necessary.

A communication was received from the British Empire Producers' Organization, stating that it was proposed to found an Imperial Sugar Research Association, with research laboratories in England, and asking for Australia's co-operation. The proposal was submitted to the Departments of Agriculture of Queensland and Victoria, and the Director of the Queensland Central Sugar Mills, all of whom approved of the scheme, and copies of their replies were forwarded to England.

The desirability of cultivating in Australia **plants and herbs yielding essential oils** used in perfumery and medicine has been brought before the Executive on several occasions. The local demand for such products is comparatively small, and it is probable that there are only a few plants of this nature whose cultivation is likely to be commercially successful unless an export market can be opened up.

The cultivation of medicinal plants is being investigated by a Medicinal Plants Board appointed some years ago by the Victorian Government. Seeds of a large number of medicinal plants have been distributed by this Board to localities widely spread over Australia, and when reports of the experiments have been received and collated, it should be possible to decide which

plants can be most suitably grown in particular localities. Naturally such information will take some years to obtain. The Executive is considering the question of obtaining similar information with regard to plants whose essential oils are used in the manufacture of perfumery and essences.

Finally, whilst the many introduced crops referred to above have received consideration, the possibility of cultivating native plants has not been lost sight of. On the recommendation of the Agricultural Conference, a Committee to deal with the collection, propagation, improvement, and cultivation in suitable areas of the most promising **indigenous grasses and fodder plants**, has been appointed, under the chairmanship of Mr. E. Breakwell, Agrostologist of the New South Wales Department of Agriculture, and comprising representatives of all the States. This Committee has only recently commenced its work, and a report on its operations to date will be found in paragraph (ii) below.

(i) *Commonwealth Flax Industry Committee: Progress Report.*—The Committee appointed by the Commonwealth Government under the War Precautions Flax Regulations to control and develop the Flax Industry in Australia held its first meeting on 29th March, 1918. The Committee consists of Mr. Thomas Hogg (Chairman), representing the Advisory Council of Science and Industry, Mr. J. E. Robilliard, an officer lent by the Victorian Agricultural Department as the Agricultural Expert, and Mr. E. R. Morton, representing the growers. The Secretary is Mr. R. B. Ward.

As the quantity of seed available for sowing was limited, the Committee deemed it advisable to concentrate its efforts for this season in Gippsland, in which district it is known that flax can be successfully cultivated and where there are existing mills. Mr. Robilliard and the Secretary made several visits to Gippsland, and personally interviewed a large number of farmers, besides holding meetings in the more important centres. The campaign was very successful, the whole of the available seed having been put into cultivation.

The total area sown is about 1,600 acres, of which 1,150 acres have been sown in the Drouin-Warragul district, and 450 acres round about Koo-wee-rup. There have been flax mills in the Drouin district for many years, but the increased acreage this season necessitates the erection of additional machinery, and the Committee has this matter now in hand. The cost of fibre production is at present under serious consideration. No decision as to what price should be paid to the miller has yet been made, but the Committee is endeavouring to fix such a price as will be equitable to both grower and miller.

Although the Committee has been compelled to concentrate in Gippsland for this season, a quantity of seed has been distributed to other farmers throughout Victoria for experimental cultivation, and it is hoped that some of these experiments will prove sufficiently successful to encourage the growing of flax on a commercial scale in districts other than Gippsland. The Committee is also making experimental sowings of New Zealand seed in order to test its fibre-producing qualities. All growers of flax this season are supplying statistical data as to the seeding and fertilizing of their crops, the nature of their soil, &c., and the Committee hopes that the information thus collected will prove of material value to growers of this crop in future years.

(ii) *Progress Report of Work of Standing Committee on Indigenous Grasses and Fodder-plants.*—Seeds of certain native grasses that were proving promising in New South Wales under cultivation were distributed by Mr. Breakwell for trial in the other States, and small quantities of certain seeds have also been forwarded by Mr. Spafford from South Australia for trial in New South Wales.

Instructions concerning sowing were issued with the seed and the members of the Committee to whom the seeds were sent have reported that the seed would be sown at various experimental stations as soon as the warm weather arrived. The ultimate object in view in establishing the plots of native grasses and fodder plants is to improve the grasses and plants by cultivation and selection so that a pasture from the seed of these can be assured. The work of cultivation and selection will require skilful supervision and direction, and unless such is carried out good results cannot be anticipated. The members of the Committee are, however, enthusiastic as regards the work, and, provided the different Agricultural Departments co-operate in a practical manner, good results should ensue.

5. Miscellaneous.—Several other matters of interest to the Agricultural and Pastoral Industries have engaged the attention of the Advisory Council during the year and are referred to in other sections of this report.

The question of fertilizers is dealt with in the section on Chemistry (p. 38), where sources of potash, the Australian requirements of nitrogen, and the utilization of local phosphates are discussed. In connexion with phosphates the Agricultural Conference passed the following resolution:—

“That this Conference welcomes the proposal of the Advisory Council to investigate the utilization of Australian phosphates, and suggests that this investigation should include manurial trials, particularly on pasture lands, in those of the States which possess such phosphates.”

Other inquiries in progress which should prove of indirect benefit to the pastoral industry are those on tanning methods (p. 43), on the by-products of wool-scouring (p. 41), and on the sterilization of milk (p. 44).

B.—FOREST AND VEGETABLE PRODUCTS.

1. General.—The vegetation of Australia is highly peculiar, a great number of the commonest and most widely distributed plants of the continent being quite distinct from those of other countries. Many whole groups of plants, including the genus *Eucalyptus*, which includes most of our forest trees, are entirely Australian. The fact of this high degree of peculiarity in our flora renders it essential that for the full development of the forest and vegetable resources of our continent researches into the products of all our indigenous plants should be conducted. It is not improbable that work of this nature may reveal new oils and drugs of importance to mankind, new sources of dyes and tannin, or timbers specially adaptable to certain particular uses. Most of the drugs, spices, &c., of India and America were discovered and utilized by the natives of those continents before intercourse with Europe opened up a trade in these products. In Australia, however, the natives made very little use of the indigenous plants for such purposes. In the early days of settlement primitive experiments were made, and the useful properties of some Australian plants discovered. More recently definite chemical researches have been carried out on scientific lines in various States, but especially at the Technological Museum, Sydney, and much important information obtained. Nevertheless the work is still only in its infancy, and there can be no question that further researches of this nature are urgently required. They should form an important part of the work of the Institute of Science and Industry.

Whilst the Executive Committee has continued to collect information on this subject, and has subsidized a number of researches on various vegetable products, it has been unable with the funds at its disposal to deal with the larger aspects of the subject. For such research a properly equipped Forest Products Laboratory is essential, and such a laboratory is undoubtedly one of the first that the Directors of the permanent Institute should establish.

The Advisory Council was represented at the Inter-State Forestry Conference held in Perth in November, 1917, by Mr. E. A. Mann. On behalf of the Executive, Mr. Mann laid before the Conference the proposal which had been made by the Tasmanian State Committee that all available information as to the forest products of Australia should be collected and published. The Conference passed a resolution supporting the proposal, and appointed Mr. H. H. Corbin, Lecturer in Forestry in the University of Adelaide, to collect the information from the State Departments of Forestry.

It was decided that it would be advisable to ask for the information under sectional headings, and a commencement has been made in collecting data as to the physical characteristics of Australian timbers and as to the properties of Australian gums and resins.

2. Timber and Timber Products.—The shortage of shipping has led to an increased demand for Australian timbers for local use, and this has stimulated inquiry into the reasons why local timbers have in the past so frequently been passed over by architects and others in favour of foreign woods. The chief reason alleged is that the **seasoning of local timber** is often unsatisfactory. The question of the best methods of seasoning Australian woods is one that demands prolonged scientific research, and this should be one of the main branches of inquiry undertaken by the proposed Forest Products Laboratory.

An allied question is that of determining the **best season for felling** Australian timbers. This matter has been brought before the Executive by the Australian Natives' Association of Victoria, and inquiries made by the Executive indicate that, though there is naturally a good deal of empirical knowledge on the subject, this does not rest in most cases on definite experimental evidence. Since a good deal of valuable evidence on the subject could probably be obtained by the officers of the Forestry Departments, the Executive has asked Mr. H. R. Mackay, Conservator of Forests, Victoria, to draw up a scheme for the collection of exact information, which will then be submitted to each of the States for their consideration.

The **destructive distillation of timber** is an industry which is steadily increasing in importance in many parts of the world. A serious obstacle to the development of the industry in Australia is the lack of markets for many of the chemical products of distillation and the comparatively small demand for charcoal. Wood distillation is, however, being undertaken in both New South Wales and Victoria.

The enormous waste associated with timber cutting in Australia, due to the fact that the timber mills are almost entirely operating on natural forests, has recently stimulated inquiry as to the possibility of using this waste for distillation. The waste is probably greater in Western Australia than in any of the other States, and since the main timbers operated upon in that State are only two—jarrah and karri—if methods of profitably utilizing the waste from either of them could be discovered, a very large supply of the material would be available. At the request of the Western Australian State Committee, the Executive arranged with Messrs. Cuming, Smith, and Co. to have experimental tests of these timbers made at the firm's works at Yarra Junction, Victoria.

The Executive is much indebted to Messrs. Cuming, Smith, and Co. for their kindness in undertaking these tests gratuitously and supplying other information. The Western Australian Committee considers that further distillation of these timbers with special control of temperature, and continued for a longer period, would be likely to lead to more promising results, and has urged that further work on these lines should be undertaken. The Executive has decided, however, that this is another matter which must await the foundation of a Forest Products Laboratory properly equipped for such researches.

The utilization of timber for **wood-pulp** is another matter which has continued to engage the attention of the Executive. During the year the pulp-mill of the Queensland Pine Co. Ltd. has recommenced operations at Yarraman Creek, where the waste from hoop pine is converted into pulp. The scarcity of native soft-woods, and the fact that they grow in mixed and not in pure forests make it certain that if Australia is to produce wood-pulp on a large scale from such woods, they will have to be specially grown for the purpose.

From various sources the Executive has learnt that in France, Spain, and America introduced Australian bluegums are being used for the manufacture of paper-pulp. Further particulars are being obtained, but from those already received it seems probable that some, at any rate, of our eucalyptus trees may prove to be satisfactory for this purpose when young, even though the timber of the mature trees is unsuitable. If the information already received is confirmed, the cultivation of pure forests, of certain species of eucalypts for pulping purposes may prove to be practicable commercially.

In other countries, especially the United States and Scandinavia, at the present time certain soft-wood trees are being largely planted as a crop to be utilized for pulping. The trees chiefly planted for this purpose are spruces, and the Executive received from Mr. D. W. Paterson a memorandum urging that spruce-trees should be largely planted in Australia. Inquiries were made in New South Wales, Victoria, and Tasmania, and also in New Zealand, as to the growth of spruce in localities where it had been planted. Reports were somewhat contradictory, and, on the whole, it would appear that the spruce is not a very rapid-growing tree under Australian conditions. It is possible, however, that in the mountainous parts of Victoria and in Tasmania, the spruce might be profitably grown for pulping, and the Executive has urged that experimental plantings should be made in these localities as soon as possible. The Victorian Forestry Department has stated that it is intended to plant these trees on the high plains shortly.

Probably the only softwood tree which has already been planted in Australia in sufficiently large areas to make it worthy of consideration is the Remarkable Pine (*Pinus insignis*), of which there are large plantations in South Australia. Mr. H. H. Corbin has kindly supplied the Executive with particulars of these plantations and a discussion on their possibilities for paper-making which appears in paragraph (i) below.

(i) *Possibility of utilizing the Remarkable Pine (Pinus insignis) and the Maritime Pine (P. pinaster) for Wood-pulping in South Australia.*—Mr. H. H. Corbin, Lecturer in Forestry, University of Adelaide, reports that of the species of timber grown in South Australia the most promising for pulping are *Pinus insignis* and *P. pinaster*. Soft white wood comparatively free from knots and resin is generally regarded as the best with which to achieve commercial success in the production of wood-pulp. This being so, *Pinus insignis* timber is specially to be recommended.

An objection has been made that the presence of resin in pine timber makes it impossible as a good pulp wood. It is well-known in South Australia that the tree in this country is a very poor yielder of resin, and that after the timber is cut and dried for a day or so, the resin, which seems to be practically all at the cut ends, gives very little trouble, and the wood seems to be particularly free from resin. The fact that the Americans are testing such pines as *Pinus palustris*, the Pitch Pine or Longleaf Pine (see Bulletin 72 of the U.S. Department of Agriculture), one of the pines having a high resin content, is also encouraging from the point of view of the *Pinus insignis*. It seems that the saponification of the resin in such timbers as the pitch pine is possible, and that such timbers can be treated advantageously by the sulphate process of making chemical pulp, hence in the *Pinus insignis* timber there should be no insuperable difficulty in obtaining chemical pulp.

In order to reduce the resin content of such wood as the *Pinus insignis* and *P. pinaster*, it might be very advantageous to "tap to death" the trees before felling for pulping, and thus possibly obtain a valuable turpentine and resin bye-product and produce a better wood-pulp raw material. The *Pinus pinaster* will produce a timber in the older tree with a well-defined brown duramen which would in the case of manufacture of some classes of paper necessitate bleaching.

Silviculturally, *Pinus insignis*, and to a less extent *P. pinaster*, has several important advantages over other species in South Australia:—

1. The trees grow quickly, producing in the case of *P. insignis* an increment of 333 cubic feet per year per acre, or 10,000 cubic feet in good *insignis* soil and climate.
2. In the case of *Pinus pinaster* a good acreage and volume can be obtained on poor sandy soils and in wet places.
3. In all plantations and pine areas thinnings are an advantage both in producing clean timber and in giving an early return, but are only in exceptional cases merchantable. Thinnings could be used with great advantage, as can the whole of any tree to the top, except the knots, in pulp manufacture.

The pine timber volume yield under closer planting with early thinnings can very possibly be increased above that obtained in the present system of planting 8 feet x 8 feet in all classes of soil. The whole question is one of importance, and it should be well worth while making preliminary investigations and experiments.

In South Australia, in the Wirrabara and Whyte Park forests there are about 10,000,000 super. feet of *Pinus insignis*, more or less mature, 25 to 35 years old. In the South-East, at the Forest of Penola and Mt. Burr Forest, considerable plantations exist, but on poor soils, and there has not been any reliable survey of the quantity available.

Wirrabara Forest is 160 miles from Adelaide, of which 154½ miles are railway. Mt. Burr and the Forest of Penola are several hundred miles away on the South-East line from Adelaide, and good roads connect these forests with the railway.

Means for water transport, except from the nearest port, in all cases not less than 15 miles away, do not exist. Water for use as power does not exist in any of the forests. Water for steam power can be had in small quantities. The present supply is bore water with rain water.

3. Fibres for Paper-making. It has been indicated above that the prospects of the immediate manufacture of paper from wood-pulp produced from Australian trees are not very promising, except in the cases already mentioned. The Executive Committee has, therefore, continued to collect information also as to other fibrous vegetable materials from which paper might possibly be obtained. Through the kindness of the Australian Paper Mills Co. Ltd., a number of materials submitted to the Executive have been tested gratuitously by the Company's chemist, Mr. A. E. Clarke, and, in addition, the Executive has been supplied with reports on materials sent direct to the Company and tested by Mr. Clarke. The Committee desires to express its thanks both to the Company and to Mr. Clarke for this valuable assistance. Mr. Clarke reported on the value of the following **grasses, rushes, and sedges**:—

Spinifex Grass (*Triodia sp.*) from Western Australia ;
Blady Grass or Lalang (*Imperata arundinacea*) from Queensland ;
Button Bog Rush (*Schænus sphaerocephalus*) from Tasmania ; and
Awed Saw Sedge (*Gahnia trifida*) from South Australia.

Of these the two latter appear to be quite useless for paper-making. *Spinifer Grass* is much more promising, the yield obtained being only a little lower than that from Esparto Grass, though the consumption of chemicals was greater. As the sample from Western Australia which was tested was a comparatively stunted variety or species of Spinifex, it was decided to obtain a further larger sample. Some obtained through the kindness of the Commonwealth Railway Commissioner, Mr. N. Bell, from the Transcontinental Railway, was not superior to that already tested, but further samples of two species of Spinifex obtained from the interior of Queensland through the Government Botanist, Mr. C. T. White, were much finer, and these are now being tested.

The investigations of *Blady Grass*, made by Mr. Clarke, indicate that if this grass can be collected under specially favorable economic conditions, and low-priced chemicals assured, the pulp obtained from it can be utilized for paper-making in conjunction with about 50 per cent. of material with longer and stronger fibres, such as those from rag or chemically-treated spruce. Blady grass is being utilized for making pulp at Kamma, near Cairns, by Mr. J. Campbell, in conjunction with various weeds obtained in that vicinity.

Another material tested on behalf of the Executive by Mr. Clarke was an introduced species of **salt-bush** (*Atriplex halimus*) from Western Australia. This material was found to be quite unsuitable for paper-making.

The possibility of utilizing **prickly-pear** for paper-making has frequently been raised. The Executive Committee has received from the Government of Queensland an exhaustive report on the subject prepared by Messrs. Sindall and Bacon, the well-known English paper experts. The material supplied to them was the dry "residuum of the killing of prickly-pear by poison." They found this material quite unsuitable for the manufacture of paper, but stated that the pulp obtained could be utilized for board manufacture if mixed with a certain proportion of strong wood-pulp. Mr. Clarke has also investigated this material and obtained similar results. Owing apparently to its fresher condition, the material supplied to him contained more moisture than that supplied to England, and the results were correspondingly poorer. He states that in general there are very poor prospects for vegetable growths containing excessive quantities of moisture, and the stems and leaves (joints) of prickly-pear contain 85 to 90 per cent. moisture.

Megass or bagasse, the residual fibrous portion of the stem of sugar-cane left after the sugar has been extracted, is another material whose utilization for paper-making has been suggested. The Executive has learned from the United Fruit Co., Boston, U.S.A., that they are proposing to utilize this material, but it appears that the megass obtained in the ordinary method of crushing in sugar-mills is not very suitable, and that in order to utilize the megass profitably for paper-making it is desirable to establish a special method for extracting the sugar. In view of this fact, and the fact that most of the megass produced in Queensland is used as fuel for the sugar-mills, and that its value for fuel is greater than its probable value for pulping, there seems little prospect of the commercial utilization of megass for pulping in Australia.

4. Sources of Tannin.—The supply of tan-bark for use in Australian tanneries has for many years past been obtained mainly from two species of wattle—the Golden Wattle (*Acacia*

pycnantha) of South Australia, and the Black or Green Wattle (*Acacia decurrens*) and its varieties. As a result of the gradual destruction of wattle-trees the Australian supply has become inadequate, and has been largely supplemented by wattle-bark imported from Natal, where plantations have been formed by the utilization of Australian seed. Owing to the cheap labour available in South Africa, and the fact that the wood from the wattles is in demand for firewood in that country, where timber is scarce, there seems little chance of Australia being able to compete with Natal in the production of wattle-bark. In addition to the wattles, a valuable tan-bark is yielded by the Mallet (*Eucalyptus occidentalis*) of Western Australia, but though the useful properties of this bark were only discovered in 1903, its exploitation was so rapid that only comparatively small quantities now remain.

Apart from the three tan-barks above mentioned, a number of other barks have been shown on analysis to contain more than 20 per cent. of tannin. Most of these, however, are derived from trees which have only a limited distribution, or the bark contains other substances which act deleteriously on the leather tanned with them.

Amongst the latter, **Mangrove-bark** contains a high percentage of tannin, and the mangrove-trees from which it is derived occur on a great area of the coastline of Australia and New Guinea, but the bark has been little used in Australia owing to the fact that leather tanned with mangrove-bark has an objectionable red colour. The Executive, therefore, appointed a Special Committee in Queensland to consider the best means of utilizing the bark and possible methods of decolourizing the tan-liquors obtained from it. This Committee has continued its investigations throughout the year, and has devised a method for decolourizing the tan-liquor which has proved satisfactory on a laboratory scale. The larger scale test which it was proposed to undertake in a tannery was delayed for some months as a result of the cyclones in North Queensland, which prevented the collection and drying of the mangrove-bark. A further supply however, was received in June, 1918, and the large scale tests are now being undertaken (see paragraph (i) below).

Another material containing a considerable percentage of tannin is the kino (gum) produced by the **Western Australian Redgum** (*Eucalyptus calophylla*). The redgum tree is very widely distributed, and abundant in south-west Australia, and its kino possesses the great advantage that it can be scraped off and collected without injuring the tree, whereas with other sources of tannin the collection of the bark results in the death of the tree. Redgum, however, like mangrove-bark, imparts an objectionable red colour to leather tanned with it. The Executive appointed a Special Committee in Western Australia to investigate this material, but the grant of £300 made to the Committee was insufficient to enable it to secure the services of a tanning chemist. The Executive agreed to increase its grant to £500 on condition that the State Government made a similar grant, and a special leather chemist is now available, and it is hoped that he will shortly be at work on the problem.

(i) *Mangrove-bark Investigation.—Progress Report on Work of the Special Committee.*—The work so far has been directed towards finding a laboratory method for so treating mangrove extract that it will furnish leather free from the red colour produced by untreated bark. At first, attempts were made to decolourize the extract, without practical success. The colour could be removed by precipitating alumina in the solution, but this also removed the tannin. Bleaching could also be effected by sulphur dioxide, but the resulting solution did not produce satisfactory leather.

During the course of the above work it was discovered that the mere addition of aluminium sulphate to the untreated extract caused the leather to have a brown colour instead of the red colour produced by the plain extract. As the brown was a rather dark one, work was continued in the direction of finding a method for obtaining a light-coloured leather. About this date an abstract appeared in the Journal of the Society of Chemical Industry (15th October, 1917, p. 1056) referring to the use of aluminium sulphate for the production of light-coloured leather, to which reference may be made. As the result of observation made during the preliminary work outlined attention was directed towards a partial precipitation treatment of the extract. It was found that precipitation in the solution of aluminium hydroxide in quantity sufficient to remove about 15 to 20 per cent. of the tannin, although it did not appreciably affect the colour, caused sufficient change in the solution to enable the treated solution to produce a light-coloured leather free from red. The method of treatment consisted in adding to the solution the necessary quantity of aluminium sulphate and precipitating with sodium carbonate solution. If the quantity of carbonate is carefully adjusted, the precipitate forms slowly and settles slowly, carrying out with it some of the colouring matter. After decantation or filtration the solution is acidified with sulphuric or acetic acid, and is ready for tanning. Solutions so treated were found to give a fairly satisfactory result, provided the hide had been well-washed in two or three changes of water before removal from the lime pit. Such washing is customary with some tanners.

Further work was postponed pending the expected arrival of a supply of bark from Cairns. Unfortunately, the cyclonic weather caused continued delay in the collection and drying of the bark, and it was only received in June, 1918. Work will at once be started on the following lines:—

1. Determination of the quantities and conditions necessary for the most efficient precipitation treatment, partly with the object of working out a treatment that could be applied by the tanner to his own bark extract.
2. Preparation of a concentrated extract, suitable for—
 - (a) Dilution for the preparation of ordinary tanning solution.
 - (b) Use in concentrated form for the final treatment of the tanned hides.

It is hoped to prepare sufficient quantities of extracts to enable them to be practically tested in the tannery.

5. Other Vegetable Extracts. The possibility of producing **camphor** from camphor-laurel trees growing in Queensland was suggested to the Executive, but an investigation made at the University of Queensland indicated that the amount present in the specimens analyzed was too small for profitable extraction.

The utilization of various **gums and resins** has also been under consideration. Grass-tree resin, derived from the various species of Grass-tree (*Xanthorrhœa*) peculiar to Australia, is used to some extent in the manufacture of varnishes, and was formerly utilized as a raw material for the manufacture of picric acid. In view of the very large amount of the material available in Australia, the Executive appointed a Special Committee to investigate the substance, especially with the object of determining its actual chemical constitution. The Committee has obtained from the red resin of the Kangaroo Island Grass-tree (*X. Tateana*) a substance known as pæonol, used medicinally in Japan, not previously known as a constituent of grass-tree resin; and several other substances have been isolated, and are being investigated (see paragraph (i) below).

It was suggested to the Executive that the resin present in Spinifex-grass (*Triodia*) should be investigated. This substance is largely used by the aborigines, who obtain it by collecting and burning the grass, but on inquiry it was found that the amount of grass which would have to be collected to obtain any quantity of the resin is too great to allow of the extraction being conducted commercially.

(i) *Grass-tree Resin.*—*Report on Work of Special Committee.*—Attention has been chiefly directed, so far, to the products obtainable by steam distillation of a strongly alkaline solution of the resin. The material examined has been from three sources:—(1) Red resin from *Xanthorrhœa Tateana*, Kangaroo Island; (2) yellow (species ?), from the same region; (3) the resin of *X. Preissii*, Western Australia.

1. The red resin of *X. Tateana* gives on steam distillation from a strongly alkaline solution a distillate, which, on extraction with benzene and evaporation of the latter, produces an oil. This oil soon solidifies to a crystalline substance not hitherto, so far as can be ascertained, known as a product of the Grass-tree. It has been identified as pæonol, $C_9H_{10}O_3$, obtainable from the root-bark of *Pæonia moutan* of Japan, and used medicinally in that country. From the residual liquor, after the distillation, can be extracted, after acidification, paracoumaric acid and parahydroxybenzaldehyde, both of which have been obtained from Grass-tree resin by other observers.

2. The yellow resin from Kangaroo Island is stated by Mr. Harrison, a local resident, to be obtainable only from about 1 per cent. of the grass-trees. The same gentleman states that he has never seen a tree yielding the yellow resin in flower. Specimens of leaves, bark, &c., have been submitted to Professor Osborn, who is unable to say from their examination whether they belong to a distinct species or not, but from the results of the chemical examination there is some evidence pointing in the direction of specific distinction. The resin differs physically in other respects than that of colour from the red variety, and on exactly similar treatment yields not only pæonol, but another crystalline substance of formula $C_9H_{10}O_4$. This has not yet been critically examined, as it is thought to be desirable to collect a sufficient quantity for exhaustive investigation. There is apparently also present a very small quantity of a substance smelling like coumarin.

3. The resin of *X. Preissii* distilled under the same conditions as the other yields an oil, which has so far not crystallized, which is yellow, slightly fluorescent, and has a different smell from that obtained from the other resins. This is being gradually collected for examination.

To illustrate the tediousness of the process, it may be mentioned that the distillation of two kilogrammes (in one lot) had to be continued for at least three weeks, 200 litres of distillate altogether being collected and extracted with benzene.

C.—MARINE PRODUCTS.

1. Fish.—It is generally admitted by all who have studied the question that the marine resources of Australia are not at present utilized to an extent at all comparable with their prospective value. This was recognised by the Commonwealth Government some years ago, and, as a result, the trawler *Endeavour* was built, and spent some years exploring parts of the coastline for grounds suitable for trawling. Unfortunately, the *Endeavour* was lost at sea in 1913, and the Commonwealth has since made no further investigations of its fisheries. The work accomplished by the *Endeavour*, however, led the New South Wales Government to purchase several trawlers, and was thus the means of starting in Australia an industry which gives employment to large numbers of men in other countries. During the past year it has been announced that the Queensland Government has purchased a trawler to commence operations in the waters of that State, whilst the Victorian Government has appointed a Royal Commission on Fisheries, which is now investigating the possibility of increasing the fish supply.

Even though Australia takes so small a toll of fish from her waters, there is considerable evidence that certain species have already been depleted, and are much less plentiful in some areas than they were formerly. Fishery legislation at present is entirely empirical, as practically nothing is known as to the seasons of reproduction, rate of growth, and other important facts in the life-history of Australian marine fishes. To obtain this knowledge the establishment of a marine biological station with a proper aquarium should be the first step, and the Executive has received from Professor W. A. Haswell, F.R.S., of Sydney, a memorandum on the probable cost of establishing such an institution, which it considers should receive careful consideration from the Directors of the permanent Institute.

2. Tropical Fisheries.—A number of fisheries for different marine animals are carried on in the northern waters of Australia. Of these, much the most important is pearling, but minor fisheries exist, or might be established, for bêche-de-mer, trochus, sponges, turtles, and dugong. The Executive has referred all these questions connected with the marine biological economics of Tropical Australia to a Standing Committee consisting of marine biologists in Western Australia, Queensland, and New South Wales. This Committee has collected a considerable amount of information as to the industries concerned, but most of the necessary researches will involve special visits to suitable northern localities, and it is not likely that biologists capable of undertaking the work will be available till after the war.

During the past year the work of the Committee has been confined to two of the fisheries mentioned above, viz., trochus and sponges.

A considerable collection of **trochus-shells** was obtained from various localities, and studied by Mr. C. Hedley, Assistant Curator of the Australian Museum, Sydney. As a result, Mr. Hedley published in the *Australian Zoologist*, vol. 1, part 4, p. 69, a monograph on "The Economics of *Trochus niloticus*." It was pointed out that the annual Australian crop was likely soon to deteriorate under the present active fishery, and that, apart from the imposition of licences for fishing, no limits are set for the size or season at which trochus may be taken in Australia or other British possessions. In the Philippines and New Caledonia it is illegal to take trochus under 8 centimetres in diameter, and in the latter country trochus-fishing is only permitted between 1st April and 1st November. It is understood that the Queensland Government intends to enforce regulations for the control of the industry.

With a view to conducting an investigation of the occurrence of commercial **sponges** on the Barrier Reef, a Greek sponge-fisher was engaged by the Committee to proceed to Cooktown. Unfortunately, it was found impossible to obtain suitable boats and diving outfit, and the investigation could not be prosecuted. Mr. A. R. McCulloch, Zoologist of the Australian Museum, subsequently visited a number of the reefs between Cooktown and Cairns, and found sponges in a number of localities. Their occurrence was, however, very patchy, and in most cases they were found in exposed situations, where their collection could only be undertaken in calm weather. The sponges obtained have not yet been examined as to quality.

(i) *Investigation of the Barrier Reef for Sponges.*—*Report by Mr. A. R. McCulloch.*—Leaving Cairns, we sailed northward to Batt Reef, an area of great extent, which is incompletely charted and lying to the eastward of Port Douglas. Anchoring behind its western end, we immediately found specimens of a large sponge growing in plenty upon the huge sand-flats behind the reef, each being a foot to eighteen inches in diameter. They were of a blackish-brown colour, and were conspicuous on the white sand surrounding them, so that they could be discerned at a distance of about 50 yards. They occurred within the vicinity of coral patches, and were usually covered even at low water, though some were exposed to the air. They were either attached to the solid reef and had to be cut away with a knife, or were growing on detached fragments of coral, when they could be lifted up bodily. They were of coarse texture and filled with marine growths of all kinds, small Ophiurians being very plentiful. They were also infested with a large bivalve mollusc, *Vulsella vulsellæ*, which is characteristically associated with them, and I took a dozen of these from a moderate-sized sponge, so that it became very dilapidated and apparently worthless when they were withdrawn. Though very tough to cut with a knife when alive, this sponge will not macerate readily in salt water as do the other species, but becomes soft, sticky, and rotten under prolonged treatment. I am not aware of the proper method of cleaning such sponges, but suppose that this species would prove much more troublesome than the other cleaner species, while the shells and marine growth associated with it would doubtless impair its value even when they be removed by chemical processes. All our efforts to clean specimens failed, and we retained only some very imperfect samples for preservation, in addition to fragments preserved in alcohol. This sponge was not again noticed during the trip, though we passed over many areas which would have seemed favorable to its growth.

Being anxious to see the better quality sponges which occur in deeper water on the exposed edges of the reef, we moved to several positions among the coral patches shown on the Admiralty chart lying to the southward of the western end of Tongue Reef, which was itself clearly visible at low water. Those patches afford but poor anchorages in the prevailing south-east winds, and are so numerous as to make navigation between them impossible except to a most experienced man. They were further swept by strong tidal currents, so that the work of hunting for the sponge-growth in a small dinghy was somewhat hazardous. We investigated several reefs without success until a large patch of sponges was discovered growing on the south-eastern or weather edge of a reef, by which a strong tidal current swept with great force. They were associated with a richer growth of sea-fans and sea-whips (*Alcyonarians*) and sea-ferns (*Zoophytes*) than I observed in any other locality, which is evidently in co-ordination with the plentiful supply of clean water rushing over them in the current, without the severe action of the surf. These sponges were very dark-brown in life, almost black, and could be easily detected from the other coral-growth even without the aid of a water glass. Through the glass they were seen to be growing upon clean coral, and were in no way associated with sand as were those of coarser texture from the Batt Reef lagoon. Specimens were quickly secured in two or three fathoms of water, and they were observed in plenty all round, and extending down into deep water. They were outside of and below the influence of the surf, and the dinghy had to be so manœuvred as to avoid being swept into the reef while keeping sufficiently close to the diver to enable him to enter it quickly if attacked by sharks, which were in the vicinity. One large specimen weighed 26 lbs. when first removed from the water, and was about 20 inches long by 12 wide, and about 12 inches thick. These "Black" or "Reef-sponges," as they were called, were less tough to cut with a knife than the Batt Reef Lagoon sponges, and were of a finer texture, while the thin epidermis covering them was very delicate, and came away readily with handling. They were comparatively clean and free from associated growths,

though a few large Ophiurians were living in their inter-stices. They macerated readily in salt water, about 30 or 40 hours sufficing to soften all the animal matter in them sufficiently to allow of it being squeezed out with the hands, leaving the sponge roughly cleaned and comparatively bleached.

The maceration of the sponges secured was a source of great difficulty on our small boat, and the smell of the rotting animal matter became very unpleasant. Our supply of fresh water was too limited to permit of its use for maceration purposes, so I was dependent upon a constant supply of salt water in a small tub and some kerosene tins to do what little was possible. As already noted, the "lagoon sponges" would not macerate under such conditions, but gradually rotted into a soft black mass, which gave off a very strong and unpleasant smell. The Black or Reef-sponges, however, macerated readily. When squeezed while in process of maceration, the sponges give off a soapy-looking substance, which forms a lather on the water very similar to soap-suds in appearance. I also noted that one's hands became very clean and white after squeezing the sponges for a while. Having learnt from a chemist at Cairns that boiling was an effective way of cleaning the sponges, I ran into Bloomfield River for a day to boil on its banks a number of specimens which were secured for the purpose. This was quite disastrous, as the process failed to dissolve the black epidermis which had dried upon them, and it did not dispose of the animal matter in them. They became very soft and brittle, and were soon rendered quite worthless. Bleaching with chloride of lime was also tried, but it completely rotted the horny fibres of the sponge. Roughly cleaned sponges were said to have been successfully treated in Cooktown by further maceration in a solution of permanganate of potash, which dissolved out all the animal matter, and then with a weak solution of hydrochloric acid, which not only bleached the sponge, but also removed any calcareous matter associated with it. The lack of these chemicals, and the impossibility of securing them locally, prevented me from experimenting in this direction.

Having heard much of the abundance of sponges on the outer Barrier reefs, we seized the opportunity afforded by a favorable spell of weather, and ran out to St. Crispin Reef, 30 miles eastward of Mount Pieter Botte, and one of the extreme outer Barrier reefs. This is a large curved reef affording a good anchorage in its lagoon, and three days were spent in searching over its extent for sponges without success. Excellent tides exposed the extreme outer edge, which is precipitous and very rugged, with irregular crevices, bays, and projecting rocks. These are of hard coral-rock conglomerate, and there is nothing loose whatever within 20 yards of the edge of the reef, everything being swept clean by the heavy surf which breaks upon it. Small boulders and table-like growths of coral provide shelter for innumerable animals, but they are firmly attached to the reef and defy movement; they are largely covered with soft corals and *Xenias*, while living Madrepores are scattered here and there, but the mass is largely overgrown with Nullipores. Careful search along this surf-swept reef was rewarded with a very few specimens of a fine textured sponge, which was preserved in alcohol. The smallest of these were on the upper surface of the reef, but a somewhat larger specimen, about 4 inches in diameter, was secured below the surf-line by diving. They were extremely scarce, however, and we regarded the reef as barren in so far as sponges were concerned.

The weather keeping favorable, we left St. Crispin Reef and ran southwards to the more exposed Opal Reef, also of the outer Barrier. I had been assured at Cooktown that sponges were so plentiful on this reef that one could walk upon them without stepping upon the reef, and I was therefore particularly anxious to investigate it. Though shown on the chart as steep-to on both sides, we found it very similar to St. Crispin Reef, a broad lagoon being enclosed behind the reef, which was precipitous on its outer edge. Though the tides did not permit us to do much wading on this reef, we rowed several miles over the lagoon and along the outer edge just outside the breakers. The water-glass revealed a garden of coral growths, among which fishes of all kinds were swimming in abundance, but we saw not a sign of a sponge. Though it would be premature to say the outer reefs are not favorable to the growth of sponges, our observations at St. Crispin and Opal reefs, as compared with the middle Barrier reefs, lead us to the conclusion that the sponges thrive in somewhat quieter water than the outer reefs afford, and where they are free from the more violent action of the surf while provided with an abundance of clean water by tidal currents.

The wind freshening into a stiff south-easterly breeze, we left the outer reefs to again investigate the more sheltered reefs of the middle Barrier. We searched along the weather edges of several of the reefs in the uncharted area around Tongue and Batt reefs, off Port Douglas, and occasionally found patches of black sponges occurring in similar situations and under similar conditions to those already described. Wherever they occurred they were in plenty, but they were very patchy, large areas of what appeared to be favorable situations being devoid of them. Leaving the Batt Reefs, we moved northward to the Hope Islands and Cairns Reef, the latter locality having been several times referred to as a sponge-bearing reef. Weather conditions held us up for several days, during which it was not possible to venture near the surf edges of the reefs, and even when we could examine them from the dinghy we failed to locate any further beds of sponges. We finally reached Cooktown twelve days after leaving Cairns, having sailed over 200 miles among the reefs, many of which are uncharted and without names for their identification.

3. Marine Plants.—The Executive has appointed Special Committees to undertake thorough investigations of two kinds of marine plants, viz., *posidonia* and kelp.

The fibrous portion of the leaf sheath of *posidonia* has on certain sheltered parts of the Australian coast-line formed considerable deposits in shallow water. The chief known deposits are those in Spencer's and St. Vincent's gulfs, South Australia, but the plant is also abundant in Western Australia, and it is not improbable that deposits of the fibre may be found there also. The fibre is dredged in South Australia, and a quantity of the material has been disposed of for insulating steam and refrigerating plants, house cooling, and the manufacture of bedding, for which purposes it has proved very satisfactory. The amount required for these purposes, however, is not large enough to allow of the free growth of the industry, which, to be successful, can only be worked with a large output. The Special Committee is therefore undertaking a thorough investigation of the physical and chemical properties of the fibre in the hope that the results will lead to further methods of utilizing it industrially. A summary of the work accomplished hitherto appears in paragraph (i) below.

The large brown seaweeds, known as **kelp**, were formerly utilized in many parts of the world as sources of iodine and of potassium salts. The shortage of potash due to the cutting off of supplies from the Stassfurt deposits in Germany has since the war led to their utilization as

a source of this material in several countries, especially on the Pacific coast of the United States. Kelp beds on the coast of Tasmania are also being used for the extraction of potash, but it seems clear that this industry must collapse after the war unless means are found for obtaining other useful substances from the kelp besides potash. With this object in view, a Special Committee was appointed to make investigations in Tasmania, and a report on the work accomplished to date appears in paragraph (ii).

(i) *Posidonia Fibre*.—*Progress Report of Work of Special Committee*.—From the appended summary of the results so far obtained it will perhaps be evident that considerable progress has been made, and that much of the information necessary for the full report has been secured. The investigation has been delayed to some extent by the difficulty experienced in securing continuous experimental help from competent co-workers; further, it has been by no means easy to determine an appropriate point at which the investigation should close, as so many interesting problems have presented themselves for solution as the work progressed. The economic possibilities of the fibre have been kept well in view during the research, which may now be reviewed in very general terms. The botanical characteristics of *Posidonia australis* have been established, and the results will be described in the final report. The structure of the natural filaments, as well as the form and other peculiarities of the ultimate fibres, will also be recorded and adequately illustrated by means of photographic reproductions. This section of the work is now complete.

An extended series of investigations has been carried out on the chemical characteristics of the fibre-material; and the bearing of the results upon possible applications of the fibre has been carefully considered. The observations made in connexion with the physical properties and structure of the natural filaments have been correlated with the chemical data in an endeavour to determine methods of modifying such properties of the material as tensile strength, elasticity, lustre, &c., so as to render it suitable for specific uses. A considerable variety of processes, including some which have been described in patent specifications and elsewhere, have been applied to the fibre with such an aim in view, and this aspect of the subject is still under consideration. Measurements of the tensile strength and elasticity of the commercially prepared and chemically treated fibre have been fully recorded. For comparative purposes the measurements of tensile strength have been calculated to a uniform standard, while the corresponding extensions have been suitably arranged. For this extensive series of observations we have been fortunate in having the use of the very delicate fibre-testing apparatus belonging to the Sydney Technological Museum. Very interesting results have been obtained from a chemical examination of *Posidonia* cellulose, and, in view of the importance which the deposits of *Posidonia australis* may well assume as a source of cellulose, the investigation is being continued in this direction; from the more general stand-point of the chemistry of cellulose it also appears desirable to add to the data already accumulated in connexion with the chemical nature of this particular type of cellulose.

(ii) *Utilization of Kelp*.—*Progress Report of Work of Special Committee*.—There are three kelps which grow in very considerable quantity round the shores of Tasmania, viz., Drift Kelp (*Macrocystis pyrifera*) and two Bull or Rock Kelps (*Sarcophycus potatorum* and *Echlonia radiata*). Work has been confined to the first two species taken from the Derwent Estuary.

The obvious method of extracting potash is to burn the air-dried kelp and treat the residual ash. This is crude and wasteful. In place of it, two distinct methods of treatment have been tried. Dry distillation at temperatures from 300° to 400° C. yields a dark-coloured oil of complex composition and a residual coke which contains all the salts and might be used directly as a fertilizer. The coke contains considerable quantities of potash and some iodine. The crude oil, which may have commercial value, is under investigation. As an alternative to dry distillation, the kelp may be macerated and converted into a viscous solution, from which the bulk of the organic matter is precipitated by addition of acid, leaving the salts in solution. The moist precipitate may be pressed into any convenient form and then hardened by treatment with formalin. The product turns perfectly, takes a high polish, and seems suitable for making insulators, buttons, and various other articles. Much preliminary work has been done on these lines, and the experiments are being continued.

D.—MINING AND METALLURGY.

1. Metals.—The immediate need for researches on problems connected with mining and treatment of metals does not appear to be so great as in the case of other primary industries. This is doubtless due to the fact that a large proportion of Australia's metal output is produced by companies with a large capital, which has enabled them to maintain their own research laboratories and staffs of qualified chemists and metallurgists. Nevertheless, there is wide scope in Australia for investigational work, with a view to developing new or improved processes, especially for the treatment of low-grade ores, and determining the properties of various alloys.

One of the matters originally suggested to the Committee as requiring immediate consideration was the question of the best means of **extraction of zinc** from its ores, with special reference to the electrolytic process. Since the Committee was formed, however, it has become common knowledge that the Amalgamated Zinc Co. have taken up the problem of the electrolytic extraction of zinc, and that, as a result, the Electrolytic Zinc Co. has been formed, and has made arrangements for carrying it out on a large scale. The Committee, therefore, came to the conclusion that no action was necessary in this matter.

Another matter suggested for the early consideration of the Executive was the production of **ferro-alloys** for high-speed steel. The investigations into this subject have been continued during the year 1917–18 by the Special Committee, to which Mr. E. J. C. Rennie has been added as a member. The work has so far been confined to investigations of the manufacture of ferro-chrome and ferro-tungsten, the most important alloys in the manufacture of high-speed steel. The experiments on the manufacture of ferro-chrome prove that there is no difficulty in manufacturing this alloy at a reasonable cost, providing a sufficiently cheap source of electric supply is available.

The Committee has succeeded in producing ferro-tungsten containing over 80 per cent. of tungsten by reducing wolframite ore by means of carbon, without the addition of any iron or oxide of iron. A satisfactory and economical method of preparing tungsten powder free from carbon has also been devised. A Bulletin dealing with the whole subject is in course of preparation, and will be published at an early date.

The investigations into the **mode of occurrence of gold on the Bendigo gold-field** were also continued during the year 1917-18. The main object of these investigations is to determine the principles which have caused the erratic localization of the gold shoots in the quartz reefs, and thus, among other things, to cheapen the cost of deep prospecting. It is hoped that a knowledge of these principles will reduce the enormous amount of money that has to be spent at present in resultless prospecting, and thereby assist an important primary industry which has been adversely affected by prevailing economic conditions. The main problem is intimately connected with all questions bearing on the origin of reefs, and some of the conclusions that have been provisionally formed are not only of local application, but have an important bearing on the genesis of auriferous ores in other gold-fields.

The results of the first year's investigations by Dr. Stillwell were published in Bulletin No. 4, entitled "The Factors influencing Gold Deposition in the Bendigo Gold-field," which has aroused considerable interest among mining men and geologists. Lectures have also been given by Dr. Stillwell at Bendigo before the mining managers. Since the publication of the Bulletin, further evidence of the relation of the reefs to the granitic mass to the south of Bendigo has been obtained from Maldon, where auriferous rocks have occurred right at the junction of the sediments and the granite, and a scientific conception of the nature of the formation of both saddle reefs and spurs has now been obtained.

An important question into which inquiries have been made by the Executive Committee is that of the **manufacture of aluminium**, a metal which has not yet been made in Australia. The prime requisites for the establishment of this industry are—(a) A suitable and cheap supply of electric energy. This could be obtained in Australia either in Tasmania or elsewhere if the requisite works were constructed. (b) A supply of bauxite or other suitable source of alumina. As far as is known at present, no bauxite sufficiently pure occurs in Australia, though further prospecting might result in the discovery of deposits of higher grade. Australia, however, possesses in its alunite deposits a source of alumina which would serve equally as well as bauxite, if not better. (c) Caustic soda for purification of the alumina. It is expected that this material will be manufactured in Australia before long by a group of chemical manufacturers. (d) Cryolite, which is not available in Australia, though its occurrence in Western Australia has recently been reported. (e) Carbon anodes, which could be made locally. (f) Electrical machinery, which would probably have to be imported. (g) Skilled control. The manufacture of aluminium in Australia is not an easy task, and could not be speedily accomplished, but it could be accomplished in time. It may, moreover, be safely asserted that the local manufacture of aluminium from local materials will cost more than the pre-war import price (about £80 per ton), but considerably less than that now charged (about £300 per ton).

Another question which the Executive Committee has investigated is the position in Australia in regard to **platinum and osmiridium**. The former is a rare metal with unique characters, which give it special value for many scientific and industrial purposes. The latter is an alloy of two exceedingly rare metals allied to platinum, and is used for alloying with platinum for special purposes. In Australia it is found mainly in Tasmania and New South Wales. The main uses of platinum are for the construction of electrical apparatus and machinery, of utensils and other articles which are essential in the practice of analytical chemistry, and of dental appliances, and in the manufacture of sulphuric acid. It is an essential agent also in some of the important modern processes for the manufacture of nitrogen products. Besides these and other useful applications, it is employed largely in the manufacture of jewellery.

The Executive Committee formed the opinion that steps should be taken to prohibit the use of platinum in Australia for the manufacture of jewellery, to stimulate local production of the ore, and to regulate the import and export trade so as to benefit the legitimate scientific and industrial uses of the metal, both in this country and in Great Britain. The Committee, therefore, recommended the Commonwealth Government to take steps for the control of both platinum and osmiridium. The recommendations have been approved by the Government.

(i) *Occurrence of Gold in Quartz*.—By the recognition of pre-existing rock structures in the Bendigo reefs, and by tracing the changes in these rock structures, Dr. Stillwell formed the conclusion that the dark laminæ in the quartz reefs represent the undissolved carbonaceous residues which have been left after beds of slate have been replaced by quartz. This conclusion throws fresh light on the genetic relations between the reefs and faults, and has led to the belief that the fault planes have acted as channels along which the mineralizing solutions circulated at the time of the reef formation. This means that the faults existed before the reefs, even though a reef now appears to be displaced by the fault, and it is possible to picture the mineral solutions flowing from the fault plane into the reef channel and replacing

certain beds of slate which had already been displaced by the fault. The carbonaceous residues are capable of precipitating gold, and when the solutions have passed from the fault planes into the leg reefs, the gold will be precipitated near the intersection. This interpretation has only been applied so far to leg reefs, which have been formed almost wholly by replacement. In Bulletin No. 4* it is not applied at present to the saddle reefs and spur reefs, which have only been partly formed by replacement.

Since the publication of the Bulletin further evidence of the relation of the reefs to the granitic mass to the south of Bendigo has been obtained from Maldon, where auriferous reefs have occurred right at the junction of the sediments and the granite. The evidence supports the previous conclusion that the reefs were formed from solutions given off during the final phase of the granitic intrusion. Further evidence has been obtained of the formation of the reefs by replacement of slates, and it is now believed that the process of replacement extends to sandstones so far as their matrix is concerned, while a simultaneous growth of quartz grains occurs. The result is that a reef so formed may contain a large percentage of quartz originally present in sandstone.

Evidence has been obtained to show that the saddle reefs and spurs are in a considerable measure formed by replacement, though in a subordinate degree they are fissure reefs. In fact, generally, Dr. Stillwell's work has demonstrated that the view of Nicholas expressed many years ago that replacement is important in the Bendigo reefs has wide application. This demonstration is opposed to the published work and text-book statements of the last 25 years in which fissure filling alone has been the accepted mode of origin of the reefs. A scientific conception of the nature of the formation of both saddle reefs and spurs has now been obtained and is the necessary basis for extended work on the occurrence of gold in these forms of reef. It includes the conception put forward by Dunn that a growing vein of quartz is able to push apart the enclosing walls. The veins of quartz have in many instances arisen from pre-existing fractures; but in some of the most complex systems of veins it is quite unnecessary to postulate the existence of fractures at all, as they have simply developed by crystallization within a porous rock. Further evidence has also been obtained as to the connexion of faults with quartz reefs and with the occurrence of gold.

(ii) *Aluminium*.—The commercial process for the manufacture of aluminium, as practised in Great Britain, Europe, and America, may be briefly summarized in two stages as follows:—

- (a) Pure alumina (oxide of the metal) is obtained from the mineral bauxite, which is impure alumina, by a special treatment with caustic soda.
- (b) Cryolite (a double fluoride of aluminium and sodium, found in Greenland) is fused in a specially constructed electric furnace with carbon anodes, and the pure alumina is dissolved in this liquid. The carbon anodes are oxidized and the alumina reduced to the metal, which sinks and is drawn off. The cryolite then serves for the solution of more alumina.

The prime requisites, therefore, for the establishment of the industry are as follows:—

- (a) A suitable supply of electric energy at a cheap rate.—In practice this is generally, if not always, obtained from water-power; but it seems possible that the development of Victoria's extensive brown coal deposits may, at some future date, supply electric energy at a sufficiently moderate price. The Tasmanian hydro-electric power installation is still very incomplete, and its present and immediately prospective services are already fully taken up; but when the scheme is fully developed there should be spare power available for the manufacture of all the aluminium required in Australia. Other hydro-electric power schemes have been mooted in Victoria and elsewhere in Australia, though not as yet carried out. If necessary, a special supply of water power could be obtained in any suitable locality, such as the Victorian highlands, but the requisite works would have to be constructed.
- (b) A supply of bauxite or other suitable source of alumina.—So far as is known at present, no pure enough bauxite occurs in Australia, though a low-grade variety is found in Western Australia. It is quite possible that systematic prospecting will bring to light new deposits of higher grade. Australia, however, possesses in its alunite deposits a source of alumina which should certainly serve as well as bauxite, and possibly better. The ore at Carrickalinga, in South Australia, contains about 35 per cent. of alumina, and yields it, after roasting and leaching, in a form about 93 per cent. pure, which is a higher grade alumina than all but the purest bauxite, and is suitable for further purification by caustic soda. The ore treatment also yields about 18 per cent. of sulphate of potash as a by-product, the sale of which would help very materially to pay for the extraction. The prospecting already done indicates that the South Australian deposits are probably extensive, though they are but little developed as yet.
- (c) Caustic soda for purification of the alumina.—There is no manufacture of this chemical in Australia yet, but a group of chemical manufacturers is now being formed for the purpose; the necessary raw materials are available, and it is expected that the industry will be established before long. At the present time imported caustic soda is difficult to get, even at £80 a ton; but the pre-war price was about £10.
- (d) Cryolite.—This is not known to occur in Australia, and, indeed, it is stated to be derived entirely from Greenland. Unless local sources are discovered, therefore, it would be necessary either to import the natural mineral, as is done elsewhere, or to manufacture an artificial cryolite. There seems no good reason why this latter course should not be followed, as the necessary raw materials are fluor-spar (which occurs in South Australia), sulphuric acid (which is made locally), alumina, and soda. But the process requires experimental investigation.
- (e) Suitable carbon anodes could, doubtless, be made locally after sufficient experience had been gained. They require constant renewal, as they are consumed in proportion to the amount of metal produced.
- (f) Electrical machinery would probably have to be imported in the first instance, but might perhaps be made locally.
- (g) Skilled control.—At the outset it would be absolutely essential to import a skilled manager with full experience of the aluminium industry in all its details. He would require also the assistance of scientifically trained chemists; and it is suggested that one or two of the Australian munition chemists now in England should be enabled to acquire a practical knowledge of the whole industry before their return to Australia.

* This Bulletin, entitled "The Factors influencing Gold Deposition in the Bendigo Gold-field," gives the results of the first year's work carried out by Dr. Stillwell.

As regards quantity and cost it is difficult to obtain a correct estimate of the total annual imports of aluminium, as it has been the practice to include it with other metals under one head in the official lists. Recently, however, the system of classification of metals and chemicals was altered at the suggestion of the Advisory Council, and returns for the last five months of 1917, arranged according to the new system, have been furnished. This period is, of course, too short to be fully trustworthy, but it affords ground for a rough estimate of Australia's annual requirements of aluminium, which may be put at about 100 tons a year. The pre-war price of the metal here was about £80 a ton. The present price (£300) is greatly inflated.

To produce 100 tons of the metal a year would require a plant of 500 c.h.p., which would cost £1,000 a year for power, according to the rate charged at Hobart. This £10 a ton is of course only a fraction of the total cost of manufacture, but the cost of the materials cannot be estimated till their sources are decided on. It may, however, be safely asserted that the local manufacture from local materials will cost more than the pre-war import price, but considerably less than that now charged.

The choice of site for a works must be determined primarily by the power scheme. No sufficiently cheap power is immediately available. In a year or two the choice may lie between hydro-electric power at Hobart and electric power developed in Victoria from brown coal, or a special hydro-electric installation may be found feasible at some suitable site in Victoria or elsewhere on the mainland. The raw materials would be carried by sea or rail to the works. In conclusion, it must be stated that the manufacture of aluminium in Australia is obviously not an easy task, nor one to be undertaken lightly. Nor is there any prospect of its being speedily accomplished. But it can be done in time.

(iii) *Platinum and Osmiridium*.—It cannot be too strongly urged that platinum is a prime requisite for the national industries on which the prosperity of Australia, as of other countries, depends. All industries are ultimately dependent on the chemical industries. These, again, depend on the manufacture of a few substances of basic importance, among which sulphuric acid is prominent; and the sulphuric acid manufacture demands platinum. Its influence extends even to our primary industries, for agriculture needs fertilizers, such as superphosphate and nitrogen compounds, in the manufacture of which platinum is a factor. But more, it must be remembered that all industry is directly or indirectly regulated by the work of the analytical chemist, and that many of his operations are well-nigh impossible without platinum apparatus.

With the progress of science and invention, the demand for platinum largely increased in pre-war times. Since 1914 its consumption for purely war purposes has grown rapidly. During the last year it has become evident that further supplies will soon be required for the permanent development of nitrogen fixation processes in Great Britain and the United States of America—perhaps also in Australia.

The increase in the price of the refined metal has been phenomenal, especially since the war began, and there is no sign of its stopping. Forty years ago it was £1 10s. an ounce. By 1908 it had risen to £4 15s., and by 1913 to £9 10s. In December, 1915, it was £17 10s.; in December, 1916, £22; and December, 1917, £26 (approximate prices in New York).

Concurrently with this rapid growth of the demand for platinum and of its price, and helping to explain the latter, there has been a marked decline in the production of the Russian fields, from which the greater part of the world's supply has hitherto been obtained. This is shown by the following figures culled from a British consular report (*Abstr. Journ. Indust. and Eng. Chem.* 1917, p. 906):—

Production of Platinum in Russia.

Particulars.	1909.	1913.	1914.	1915.	1916.	1917.
Ounces	214,000	158,100	156,800	118,700	85,500	63,900

Next to Russia, in order of production, come Columbia (South America), the United States, and Australia (New South Wales and Tasmania), for which the respective figures in 1914 were 17,500 ozs., 2,905 ozs., and 1,248 ozs. Since then the Australian output has decreased, and for 1917 it is estimated at only 222 ozs., but there are recent reports of a new field in New South Wales.

It seems probable that one result of recent events in Russia will be the complete cessation of the export of platinum to Great Britain and her Allies while the war lasts, and even afterwards the market may be dominated by the Central Powers. The outlook is therefore very serious. Naturally, Great Britain has prohibited the export of the metal; but this step may affect the progress of science and industry in Australia, which, though a producer of the ore, is dependent on the Mother Country for the supply of manufactured platinum apparatus.

In view of these facts, the Executive Committee is strongly of opinion that steps should be taken to prohibit the deplorable waste of platinum in Australia (and elsewhere) by its use in the manufacture of jewellery, to stimulate the local production of the ore, and to regulate the export and import trade so as to benefit the legitimate scientific and industrial applications of the metal both here and in Great Britain.

It may be mentioned that in the United States, after its declaration of war, an attempt was made by the National Academy of Sciences and other influential bodies to enlist the aid of the Jewellers' Vigilance Committee in a crusade against the misuse of the metal. This did not prove successful; but, according to a recent press cablegram, the U.S.A. Government has now commandeered all stocks of platinum, and thus taken the control of the trade into its own hands.

The Executive Committee recommended the early adoption by the Commonwealth Government of the following proposals:—

- That the Commonwealth Government should prohibit the use of platinum in the manufacture of jewellery or articles of adornment, and the sale or purchase of such articles and of the metal for the purpose of their manufacture.
- That the export of platinum in any form from Australia except under licence, should be prohibited.

(c) That the Government should call for a return of all stocks representing more than 1 oz. troy of the metal held on the day of proclamation, of—

- (i) Platinum bullion, bars, ingots, sheet, foil, wire, &c.
- (ii) Apparatus constructed partly or wholly of platinum.
- (iii) Platinum scrap, turnings, sponge, filings, sweepings, &c.
- (iv) Jewellery, chattels, and articles of adornment, consisting partly or wholly of platinum.
- (v) Salts or compounds of platinum.
- (vi) Crude platinum ore or alloys.

(d) That the Government should take power to purchase at a price to be fixed any platinum as set out in clause (c) of these suggested recommendations.

(e) That arrangements should be made between the Commonwealth and Imperial Governments to facilitate and encourage the export of platinum and platinum ore from Australia to England, and the manufacture there and re-importation into Australia of such platinum apparatus and articles as cannot be profitably manufactured in Australia, but may be needed for scientific and industrial purposes.

(f) That the Commonwealth Government should take such other steps as may appear necessary or desirable to stimulate the Australian production of platinum ore.

(g) That the Australian Metal Exchange be given the necessary powers to carry out the above proposals.

The Executive Committee also recommended that the control of the production and distribution of osmiridium should be placed in the hands of the Metal Exchange.

2. Non-metals.—Two main lines of inquiry have occupied the attention of the Committee in connexion with minerals other than metals and metallic ores. One of these is the possibility of stimulating prospecting for minerals hitherto not found or only found in small quantities in Australia, but whose products are at present imported from other countries. In this connexion the Committee has made inquiries as to the probability of finding rock phosphates (*see* page 40). The other series of problems are those connected with the utilization of materials of which large deposits are known to occur in Australia, but which have not hitherto been fully utilized. Under this heading information has been collected in connexion with brown coal, iron and aluminium phosphates, alunite and clays.

The investigations into the **alunite deposits** of Australia, and their utilization, have been practically completed. The Executive has established a Special Committee, with members in Victoria, New South Wales, and Western Australia, to investigate the question of the **utilization of the natural phosphatic rocks** of Australia for fertilizing purposes.

As regards **clays**, the Standing Committee on Chemicals has taken steps to collect and co-ordinate the data already available. This is considered an essential preliminary to any systematic investigation into the whole subject. The Executive Committee has, however, established a Special Committee in Perth, for which the necessary funds are provided on a contributory basis by the Advisory Council and the State Government of Western Australia to carry out investigations into the pottery clays of that State.

The scientific problems connected with the utilization of the minerals referred to above are mainly chemical. The investigations into alunite and phosphates are dealt with in the chemical section of this Report, while clays are dealt with in connexion with the pottery industry on page 45.

3. Proposed Imperial Mineral Resources Bureau.—In April, 1916, the Imperial Conference passed a resolution emphasizing the importance of establishing in London an Imperial Mineral Resources Bureau to collect information regarding the mineral resources and the metal requirements of the Empire, and to advise as to action to be taken for the development of the resources. In pursuance of this resolution, a Committee was established in London to suggest a constitution, and prepare a scheme for establishing the Bureau. The report of this Committee, the details of which are at present of a confidential nature, has been considered by the Executive Committee at the request of the Commonwealth Government.

The Executive Committee has reported to the Government that it thoroughly approves of the proposals to establish the Bureau, which should be actively supported by the Advisory Council of Science and Industry, and by the permanent Institute when established. The Executive also recommended that as soon as the Bureau is established a properly qualified mining engineer with metallurgical experience should be appointed to collect and co-ordinate all information regarding the mineral resources, the metal requirements, and the metallurgical processes of the Commonwealth. It has been reported recently in the Press that the Imperial Conference has approved of the scheme for the establishment of the Bureau and that Mr. W. S. Robinson has been appointed as the Australian representative on the governing body.

E.—CHEMICAL INDUSTRY.

1. General.—A large number of chemical questions have come before the Executive, and it was thought desirable at an early stage of the work to appoint a Special Committee to investigate and report on the possibilities of local manufacture of chemicals now imported. In many cases this has further involved the collection of information as to possible Australian sources of supply of the necessary raw materials. Since the Special Committee on Chemicals was first formed, numerous further questions have been referred to it by the Executive, and during the year it was decided to constitute it a Standing Committee, with a salaried part-time secretary. Besides dealing with chemical industries, the Committee has acted as advisor to the Executive on the chemical aspects of a number of other problems. The reports on Platinum and Aluminium prepared by the Committee have been given above (pages 35 and 36).

During the year the chemists of Australia have organized an **Australian Chemical Institute**, thus creating for the first time a Federal organization which can give authoritative expression to the views of Australian chemists. The existence of the Institute should be of great value and assistance to the Directors of the future Institute of Science and Industry on all occasions when they may desire to obtain the assistance or to ascertain the views of the chemical profession. The Chemical Institute has already taken over the control of the investigations initiated by the Society of Chemical Industry of Victoria on the standardization of analytical methods. The Executive Committee had previously given a grant to the Victorian Society for assistance in the work, and it recognises that results obtained are much more likely to gain general acceptance in Australia now that the research is controlled by a Federal and not a State organization. Particulars as to this research are given in the section on Standardization (page 53).

At the outset of its work the Chemicals Committee found it necessary frequently to consult the Customs reports, and it soon became clear that owing to injudicious grouping of **statistics relating to chemical imports**, the information required was often not available, and it was considered that steps should be taken to make the reports more useful. The Committee, therefore, recommended to the Executive that a Special Committee be appointed to report on the matter, and the recommendation was carried into effect. After careful consideration the Committee drew up a revised list, which was forwarded to and approved by the Comptroller of Customs, and came into force on 1st August, 1917. Since that date statistics of the imports of chemicals have been collected according to the Committee's recommendations, and, in the opinion of the Chemicals Committee, the returns already made are of considerably greater value than if they had been collected on the old lines. Before this work can be regarded as complete, however, it will be necessary to compile a guide for the Customs officers, showing under what heading any particular material should be grouped. The compilation of such a guide is a matter requiring considerable chemical knowledge and experience of the chemical trade, and arrangements for undertaking it have not yet been completed.

Representations made to the Executive during the year as to the effect of the **duty on alcohols** in interfering with scientific teaching and research, led it to collect information from all the Universities which indicated that, especially in the poorer institutions, the high price of alcohol is a serious check on teaching and research, especially in organic chemistry and biology. It was decided to represent to the Government the desirability of giving concessions to teaching and research institutions in Australia by allowing them to obtain duty-free alcohol for these purposes, as is the practice in Germany. This has always been regarded as one of the chief reasons for the rapid advance of the German chemical industry, absolute alcohol being next to water the most widely used solvent in chemical investigations.

2. Fertilizers.—Australia is largely dependent on outside sources for the raw material of artificial fertilizers, and the Executive Committee has devoted much attention to the consideration of possible local sources of phosphates and potash, with a view to reducing this dependence of our agriculture on foreign countries.

Of most pressing importance is the need for developing local sources of potash, since Australia, in common with the rest of the world, was before the war dependent on the potash deposits of Stassfurt, Germany, for her supply of this chemical. Besides the use of potash for fertilizers, it is required in various secondary industries, such as the manufacture of soap, cyanides, explosives, and fireworks. The problem is not peculiar to Australia, and the Committee has obtained reports and other information as to the inquiries into new sources of potash which have been conducted in the United Kingdom and the United States of America. The **sources of potash** which have been considered during the past year are—(a) alunite; (b) kelp; (c) suint; (d) wood-ashes; (e) saline deposits; (f) flue-dust from furnaces; (g) water-hyacinth.

(a) **Alunite** is a mineral consisting of the sulphates of potassium and aluminium, of which there is a very large deposit at Bullahdelah, in New South Wales, and smaller though purer deposits in South Australia. The Bullahdelah deposit was formerly mined and shipped to England for the

manufacture of alum, but this industry is now at a stand-still. A Special Committee was appointed by the Executive to consider the best means for utilizing alunite, of which the Australian deposits are the most extensive in the world, specially with a view to ascertaining the best treatment for the extraction of the potash. The report of this Committee was issued as Bulletin 3. As a result of its work, the Committee stated that the extraction of potash from alunite was a comparatively easy undertaking, requiring, however, a furnace whose temperature could be kept under control. Since the bulletin was published the Australian Alum Co., the owners of the Bullahdelah deposit, have undertaken a large-scale trial to determine whether their ore could be economically treated to produce a product suitable for immediate use as a fertilizer. The trial was not successful, the amount of soluble potassium sulphate obtained being much less than was anticipated, and this was traced to a secondary reaction, whereby at high temperatures complex insoluble potassium aluminium silicates are formed. The ore from Carickalinga, South Australia, does not react in this way, owing to the much smaller quantity of silica it contains. Further details appear in paragraph (i) below.

(b) The large brown seaweeds known as **kelp** contain a considerable quantity of potash, and kelp is being utilized as a source of potash on the coast of Tasmania. Details as to the products of kelp have been given under Marine Products on page 33.

(c) Suint, or **wool-grease**, contains a certain amount of potash, and if the whole Australian wool clip were scoured in Australia and the potash extracted this would probably suffice for local needs. Various methods of wool-washing are in use in different countries; in some cases the potash is first washed out with water, the fats being subsequently removed; in other processes the grease and potash are removed together and the potash subsequently recovered. The recovery of potash in wool-scouring must be considered in connexion with the production of lanoline, and the whole question of the treatment of wool-scouring liquors in Australia is being considered by a Special Committee (page 41).

(d) The extraction of potash from the **wood ashes** of saw-mills has been suggested, and the Executive Committee has collected evidence on the subject which points to the conclusion that the amount of potash is too small to render this a commercially profitable source. It is understood that experiments as to the feasibility of extracting the potash from the ash left when prickly-pear is burnt were also unsuccessful from a commercial point of view.

While the ash of the wood of various species of eucalypts has been found to be invariably low in potash, there is a concentration of this element in the leaves, and inquiries have been made as to the utilization of the residual gum leaves after "steaming" for the extraction of eucalyptus oil. These inquiries have indicated that the usual potash content of the leaf ash is about 10 per cent., as compared with 3 per cent. in the wood ash, and that if suitable arrangements could be made for the collection of the burnt ashes from a number of small eucalyptus distillers, a small amount of potash could be obtained in this way.

(e) There are throughout the southern States of Australia a large number of **salt lakes and brine springs**, and the possibility of underground waters charged with potash salts must also be taken into account. The Chemicals Committee is of opinion that a systematic investigation of all these brines and salt waters should be undertaken to determine their value as a source of potash or other salts. Preliminary inquiries have, therefore, been made from the Mines Departments of the southern States of Australia, and what information is already available is being collected.

(f) In July, 1917, it was reported in the press that a recent discovery had rendered England independent of outside sources of supply of potash salt. The replies to a cabled inquiry from the Executive indicated that the **flue dusts from blast furnaces and cement works** in England and America had been found to contain from 12 per cent. to 18 per cent. of potash (calculated as K_2O), of which about four-fifths was water soluble.

The attention of the Broken Hill Pty. Co. Ltd. and of Messrs. G. and C. Hoskins Ltd. was directed to this matter, but the analyses which they caused to be carried out showed that the bulk of the flue dusts in these Australian works only yield about 1 per cent. of water-soluble potash, and cannot therefore be regarded as commercial sources of potash. Similar inquiries were made from leading cement manufacturers with a similar result.

These low yields (as compared with European experience) are due to the greater freedom of the original ores and fluxes from potash-bearing minerals.

(g) Reports received from India showed that in that country the **Water Hyacinth** (*Eichhornia crassipes*), a South American water-weed which has become established in many warm countries and is a serious hindrance to navigation of water-ways, had been found to contain a sufficiently high percentage of potash to make it a profitable source of this material. The Executive therefore arranged to have analyses made of water hyacinth from Queensland. Details of the analysis are

given in paragraph (ii). They show that the ash, forming 17·35 per cent. of the dried plant, contains 10·66 per cent. of soluble potash (K_2O) and 3·86 per cent. insoluble. These results are promising.

The possibility of increasing the local supply of **phosphatic fertilizers** depends on either (a) the discovery locally of rock phosphates suitable for the manufacture of superphosphates, or (b) the discovery of means whereby the phosphates of iron and aluminium, of which there are considerable deposits in Australia, can be made available as sources of phosphorus to crops. As indicated in last year's report, inquiries made from the Government Geologists in all the States as to the prospects of finding rock phosphates in Australia were not very promising. A Special Committee was appointed to investigate the local phosphatic rocks, particularly the aluminium and iron phosphates, with a view to the discovery of means for increasing their "availability," as well as to determine their actual value as fertilizers in an untreated condition. A discussion on the subject took place at the Inter-State Agricultural Conference, when the following resolution was passed :—

"That this Conference welcomes the proposal of the Advisory Council to investigate the utilization of Australian phosphates, and suggests that this investigation should include manurial trials, particularly on pasture lands, in those of the States which possess such phosphates."

The Special Committee subsequently decided that it would be desirable first to make a thorough chemical investigation of local phosphatic rocks before undertaking field trials. Up to the present, however, it has not been able to secure the services of a suitable investigator to undertake the work.

(i) *Alunite*.—*Report on Work carried out since the Publication of Bulletin 3*.—Under the auspices of the Australian Alum Coy. of Sydney, who are the owners of the Bullahdelah deposit of alunite, a series of trial roastings of bulk lots weighing several tons was carried out in order to determine whether this class of ore could be economically treated to produce a product suitable for immediate use as a fertilizer, as recommended in the Bulletin on alunite. The first tests were made in a hand-rabbed reverberatory furnace, and afterwards a lot was put through an Edwards mechanically rabbed furnace, but in neither case were the results satisfactory. The wasted material upon analysis showed a large deficiency of soluble potassium sulphate, and a further series of experiments was made to determine the reason of this and the conditions necessary to treat ore of this character, high in silica contents. The results obtained prove that the potash was not volatilized, as was thought likely to be the case, but that the low percentage recovery of soluble potassium sulphate was due to a secondary reaction between the potassium sulphate, silica, and alumina giving rise to the formation of complex insoluble potassium aluminium silicates. It was found that, by a prolonged heating at the higher temperatures, practically all the potash could be rendered insoluble in water, the amount of soluble potassium sulphate in the roasted material depending on the temperature to which it had been raised and the length of time of heating. Comparative tests, made with the Carrickalinga alunite, showed that no such secondary reaction took place when it was subjected to prolonged heating at a high temperature, as was to be expected from its low silica contents. In view of this secondary reaction in the presence of silica, with ores of this character care would have to be taken to keep the temperature as low as possible, and to discharge the ore as soon as the first decomposition was complete. Overheating in any part of the charge would lead to a loss of soluble potassium sulphate, so that the rabbling would have to be thorough and effective. A furnace on the step-hearth principle, where each batch of ore could be kept separate and discharged on completion, would probably be the most suitable for this class of ore. Careful control, guided by frequent analyses of the roasted product would be necessary on a working scale to establish the best conditions for satisfactory results.

A series of experiments to determine the effect of roasted alunite on the solubility of the phosphates in superphosphate manures, when the two materials were kept mixed for varying periods of time, was made at the request of the Alunite Committee by Mr. D. A. Runting. The results show that the effect of such mixture is to cause a reversion of the phosphates to a less soluble form, and on this account it would not be advisable to use roasted alunite as a potash source for admixture with superphosphates, where the material has to be kept for any length of time before use. As, under ordinary conditions, the reversion of superphosphate in the soil is very rapid, there would be no deleterious effect if the roasted alunite was used separately. A pamphlet giving details of the results obtained is in course of preparation.

(ii) *Water Hyacinth*.—The sample of Queensland water hyacinth (*Eichhornia crassipes*. Solms.) which was analyzed consisted of the whole plant and a little earth adhering to the roots, and air-dried. It was finely ground in a coffee mill and thoroughly mixed. The result of the analysis is as follows :—

WATER HYACINTH : ANALYSIS.

Particulars.			Moisture (at 95° C. in Vacuo).	Ash.	Organic Matter.
Per cent.	..	..	16·84	17·35	65·81*

* Including nitrogen, 1·12 per cent.

ANALYSIS OF THE ASH.

Particulars.	Per cent.—	
	Of Sample.	Of Ash.
Insoluble in hot water	13·58	78·27
Soluble in hot water	3·77	21·73
The insoluble part consists of—		
Silica, sand, &c.	6·88	39·66
Ferric oxide and alumina	2·01	11·58
Manganese oxide (Mn_3O_4)	0·16	0·92
Calcium oxide	1·73	9·98
Magnesium oxide	0·53	3·05
Sodium oxide (Na_2O)	0·17	0·98
Potassium oxide (K_2O)	0·67	3·86
Phosphoric anhydride	0·43	2·48
Chlorine	0·09	0·52
Carbon dioxide, sulphuric anhydride, &c., by difference	0·91	5·24
The soluble part consists of—		
Alumina	0·10	0·58
Calcium oxide	0·06	0·34
Sodium oxide	0·23	1·32
Potassium oxide	1·85	10·66
Chlorine	1·04	5·99
Carbon dioxide, SO_3 , &c., by difference	0·49	2·84
Phosphoric anhydride	a trace	

The soluble matter was obtained by washing the ash from 10 grams of the sample on a filter with successive portions of hot water until the volume of the filtrate became 250 c.c.

3. Other Chemicals.—A number of other chemical industries have been considered by the Executive and the Chemicals Committee during the year, including the recovery of lanoline and potash from wool-scouring liquors, the distillation of coal-tar, the utilization of Queensland-grown cotton for the manufacture of cordite, the extraction of bye-products from the residues of eucalyptus distillation, and the manufacture of alkalis, nitrogen compounds, arsenic compounds, hydrogen, rennet, substitutes for shellac, and anti-fouling compositions for painting the bottoms of ships. Other chemical matters dealt with in different sections of this report are the utilization of kelp (page 33), the products of grass-tree resin (page 30), the manufacture of tin-plate substitutes (page 51), the utilization of clays (page 45), and the manufacture of industrial alcohol (page 48).

In the report to 30th June, 1917, it was pointed out that hitherto only a very small portion of the wool exported from Australia has been scoured before shipment, and that no recovery of lanoline and other valuable **by-products contained in wool-scouring liquors** was made. A Special Committee was therefore appointed at Geelong to consider the whole question. Soon after its appointment the Committee reported that the Geelong City Council had prohibited the discharge without previous purification of wool-scouring liquors into the river. It was similar action by local authorities in England which first led to the recovery of the wool-grease from wool-washing liquors in Bradford and elsewhere. The process first commenced under compulsion is now almost universally adopted there since it has been discovered that the bye-products obtained more than pay for the cost of treatment of the liquors. It is not clear that this would be the case in Australia, since lanoline, the chief product, is not in sufficient demand, and it would be necessary to find an oversea market for most of that produced. The Committee is considering this aspect of the matter before considering the method of treating the liquors which would be best suited for adoption under Australian conditions.

The attention of the Executive was drawn to the fact that the local demand for carbolic acid, cresol, and lysol substitutes could not be met by manufacturers in Australia, owing to the inadequate supply of the raw materials. The raw materials required for this purpose are the **oils distilled from coal tar**, between $170^{\circ}C$. and $230^{\circ}C$., known as "middle oils." Under the War Precautions Act the Directors of Munitions have assumed control of the distillation of light oils from coal-tar to prevent waste of benzene and toluene—valuable sources of explosives; the middle oils contain phenol, which is an equally valuable source for the manufacture of explosives. The Executive therefore recommended to the Directors of Munitions that control should also be assumed

over the middle oils, which like the light oils are prohibited from export from England. By this means Australia would be rendered more nearly self-contained in the matter of explosives, and at the same time the supply of carbolic acid, cresol, and lysol substitutes would be increased.

In the process of **eucalyptus distillation** a black liquor is left after the oils have been driven off, and it was suggested that this liquor should be examined chemically, with a view to finding uses for it. It is already used to a considerable extent as a boiler disencrustant and as a dressing for animals. The Executive considered that the eucalyptus distillers should first be organized into an association, which might provide a part of the necessary funds for the research.

The **alkalies**, caustic soda and sodium carbonate, are used in so many chemical industries that their increasing cost in Australia since the outbreak of war is a very serious matter. During February, 1918, the Prime Minister summoned a conference of the leading chemical manufacturers of Australia to discuss the question, as a result of which all the principal firms agreed to unite to establish the industry in Australia.

As indicated in last year's report, the Committee came to the conclusion that, as there was no immediate prospect of Australia being cut off from the supply of Chili saltpetre, the question of the fixation of atmospheric nitrogen for the production of **nitrogen compounds** would be best postponed until after the war, when information as to the experience of other countries with regard to various processes would be more readily available. Subsequently a request for information as to Australia's nitrogen requirements was received from the British Nitrogen Products Committee, which had been formed to consider the relative advantages for Great Britain and for the Empire of the various methods for the fixation of atmospheric nitrogen from the point of view both of war and of peace purposes. A Special Committee was formed to obtain the information, and reported that the total requirements of combined nitrogen in Australia amount to 2,700 tons per annum, estimated as nitrogen, and that this amount is less than the amount contained in the ammonium sulphate produced in the gas and coke works in the country. The complete report of the Committee, which was forwarded to England, appears in paragraph (i) below. Subsequently a request for other particulars was received, and these are now being obtained.

The demand for **arsenic compounds** in Australia for utilization in dips and sprays, and for the destruction of prickly-pear, has much exceeded the supply since the outbreak of the war. The Committee has given consideration to certain questions arising out of this. In view of the poisonous nature of arsenious chloride, which is being used for prickly-pear destruction, the Committee drew the attention of the firm engaged in its manufacture to the desirability of supplying to purchasers instructions as to the precautions necessary when using it. A set of instructions has been prepared in conjunction with the firm concerned, and will be issued with future consignments.

The question of providing suitable **substitutes for shellac** is under consideration by the Chemicals Committee, on behalf of the Board of Trade, whilst the possibility of manufacturing locally **anti-fouling compositions** for treating the bottoms of ships is being investigated on behalf of the Department of Defence.

As was reported in the last report, a local firm undertook the manufacture of **rennet** on a commercial scale, subsequent to its prohibition for export from England. This firm has found that the departmental regulations with regard to the use of alcohol in manufacture present a serious obstacle in the way of establishing the industry, and the Executive is supporting it in its representations to the Department of Trade and Customs, with a view to modification of the regulations in this case.

(i) *The Nitrogen Requirements of Australia.—Report of Special Committee.*—With the exception of a small amount of shale, coal is the only source of combined nitrogen in this country. According to the information available to the Committee, the amount of combined nitrogen produced by the carbonization of coal and recovered is about 3,250 tons per annum; that which is produced in beehive coke ovens and lost is estimated at about 800 tons. Of the amount recovered, about 3,000 tons is sold in the form of ammonium sulphate, 250 to 350 tons as ammonia. Of the sulphate practically half is exported; hence it would appear that Australian requirements of combined nitrogen in this form are rather more than 1,500 tons per annum.

It is difficult to estimate the probable future requirements of nitrates, practically all sodium nitrate, as the imports have increased largely since 1914, having risen from about 3,300 tons to about 8,000 tons during 1916–17. Taking the net import for this latter period, and including the nitrogen contained in the average import of potassium nitrate, it is found that Australian requirements of combined nitrogen in the form of nitrates is 1,200 tons per annum.

It is estimated that the total requirements of combined nitrogen in Australia amount to 2,700 tons per annum, calculated as nitrogen, that is less than the amount contained in the ammonium sulphate produced in the country.

2. Food Supply.—Two systematic investigations coming under this head have been continued during the year 1917-18. One of these is the experimental work on the electrical sterilization of milk, which is being carried out at Sydney by Dr. J. B. Cleland and Mr. W. H. Myers. The other is the investigation, which is also being carried out at Sydney, by Professor H. G. Chapman, assisted by Mr. F. Elliot and Miss M. Lilley, with the object of discovering "races" of yeasts which will produce more rapid ripening of doughs in the manufacture of bread.

As regards the **electrical sterilization of milk**, it was reported that work carried out at Liverpool, England, before the investigations were commenced in Sydney, showed that this method of sterilization may be conducted on a large scale, and that it has certain advantages over any other system. No complete scientific investigation of the process has yet been made, however, and the exact means by which the electric current destroys the bacteria in the milk is not known. Further, the best and most economical conditions of working have not been ascertained. During the year 1917-18, further experiments, utilizing several distinct methods of research, have indicated that the sterilizing effects produced by alternating currents are not due to shock, but are of a secondary nature. It does not necessarily follow, however, that the method adopted at Liverpool is to be regarded as impracticable on a large scale, and this phase of the question still remains to be investigated. Experiments were also carried out by the Committee with direct currents, and whilst it was ascertained that sterilization could be so produced, the change in the nature of the milk prohibits the use of direct currents for the purpose in view.

The investigation into **fast doughs** have been continued in a bake-house under trade conditions, and represent the application of the results of the experiments previously performed in the laboratory. In the last Report of the Executive Committee it was pointed out that the results of this investigation may have an important bearing on the solution of the day-baking trouble, and the results of the past year's work under practical conditions show that the time occupied in making the bread from start to finish has been reduced to not more than ten hours.

The question of taking steps to overcome some of the difficulties experienced by those engaged in the **cold storage of foodstuffs** was brought before the Executive Committee, through the New South Wales State Committee, by Mr. W. J. Williams, Manager of the Municipal Cold Storage Works, Sydney. While it appears that systematic research work on cold storage problems cannot be conducted until the permanent Institute is established, it was considered desirable to take immediate steps for the collection of such data as is necessary for the formulation of a scheme of research. The Executive accordingly appointed a Special Committee consisting of Messrs. R. Crowe (Exports Superintendent, Victorian Department of Agriculture), W. J. Williams, and F. W. Vear (Fruit Exporter) to draft lists of questions for the collection of the desired information, and it was decided to deal first with problems relating to the cold storage of fruit. The Special Committee has prepared lists of questions relating to the growing and preparing of fruit for cold storage, the storage of fruit, and the results obtained. These questions will be circulated among fruit-growers, proprietors of cold stores, and persons dealing with fruits from cold stores, respectively, and when the replies are received it is proposed that the Special Committee shall make recommendations to the Executive for the initiation of experimental work.

(i) *Electrical Sterilization of Milk.*—In the last Report of the Executive Committee it was pointed out that preliminary investigations into the effect of passing alternating currents through jellies seeded with bacteria gave negative results so far as the germicidal action of the currents was concerned. The opinion was expressed that the sterilization produced by the alternating currents (of normal frequencies) in the Liverpool Corporation's apparatus depended upon one or more of the following factors:—(a) The transitory local heating of the milk at the electrodes; (b) "electric shock"; (c) chemical changes.

Very careful experiments, utilizing several distinct methods of research, have indicated that the alternating electric currents play no appreciable part in the sterilization effects produced, other than by local heating at the electrodes, as indicated in suggestion (a). Whilst, in view of the definite advices to the contrary received in the official reports from England, this result is disappointing, it does not necessarily follow that the method adopted at Liverpool is to be regarded as impracticable on a large scale, for the commercial sterilization of milk; this phase of the question still remains to be investigated.

Careful experiments were also carried out upon the effects produced by direct currents of electricity passing through milk; and whilst it was ascertained that sterilization could be so produced, the profound change in the nature of the milk (such as the precipitation of casein at the positive electrode due to the acidity produced by electrolytic decomposition of the milk whey) would appear to prohibit the use of direct currents for this purpose.

The possibility of electrically sterilizing milk in a commercial manner without perceptibly modifying its properties in other directions appears, therefore, to depend upon:—(a) Local and transitory electrical heating of every portion of the milk; or (b) some other form of electrification other than the use of direct, or normal alternating, currents, such as actinic radiation, or, possibly, high frequency currents, &c.

These methods have not yet been investigated by the Special Committee, mainly owing to pressure of urgent work in other directions; but some preliminary steps have been taken and particulars obtained of similar work carried out elsewhere.

Owing to the assistance rendered to the Committee by several members of the University teaching staff, the Department of Public Health, and the Tramway Department, the actual cost to the Advisory Council of the investigations so far carried out has not exceeded more than a nominal sum.

(ii) *Yeasts for Bread-making.*—The most noteworthy experiment performed during the last year's work has been the continuous subculture of a stock of yeast in the bakehouse during a period of almost six months.

The experiment started in the middle of January, 1918, and is still in progress. The growth of this yeast has been carried out in the bakehouse under trade conditions, and represents the application of the results of the experiments performed during the preceding twelve months in the laboratory. Throughout this lengthy experiment a record has been kept of the manufacture of the bread made with the yeast prepared at each growing. The record keeps account of a number of conditions which may be of practical utility. These conditions include among others the weight of flour, the temperature of the bakehouse, the temperature of the dough to the placing in the oven and the weight of bread produced. It has been found that the number of loaves which will be obtained from a dough can be estimated with accuracy if the weight of the dough, when mixed, is ascertained, or if the weights of flour and water used at mixing the dough are known. During this experiment many different flours have been used to insure that similar results of speedy ripening could be obtained with any flour. Every dough has been made with 250 lbs. of flour, *i.e.*, with one-eighth of a ton. During the whole experiment the yield has averaged 174 loaves, *i.e.*, 1,392 loaves to the ton of flour, or 104 loaves to the bag of flour. The weight of the bread, weighed fifteen hours after baking, has averaged 354 lbs., or 6 lbs. over the lawful weight. On no occasion has the weight of the bread been less than 3 lbs. over the lawful weight of 348 lbs. The time occupied in making the bread from start to finish has occupied not more than ten hours.

The yeast has been grown in the bakehouse in the following way:—One oz. of hops is placed in about three quarts of water contained in an enamel bucket, and the mixture is boiled for twenty minutes. The liquid is strained from the hops. Two pounds of crushed malt and one-half pound of flour are added to the liquor when the temperature has fallen to somewhat above 155° F., and the mixture is maintained at this temperature for at least two hours. In practice this stage has been frequently prolonged to four or five hours for convenience in working. The wort is strained from the extracted malt and its volume made up with water to just less than 1 gallon. This is done by filling up to a mark on the bucket. The wort is poured into an enamel stewpan in which the gallon forms a layer of about an inch on the bottom. The stewpan is heated until the wort boils vigorously. The lid is placed on the covered stewpan and the contents allowed to cool. When the temperature reaches 80° F. the yeast from the previous stock is added and the lid replaced. The yeast from the previous stock is obtained by taking a covered pint dipper rinsed with boiling water within and without, and by removing a full dipper of the yeast when the stewpan of yeast is first uncovered. The dipper of yeast stands in a clean cupboard for five or six hours to settle. The yellowish liquor is poured off just before use and the yeast is added to the wort. The mixture of wort and yeast is vigorously beaten with an egg whisk, rinsed in boiling water, for five minutes. After an hour the mixture is again beaten in the same way for five minutes. The yeast then stands for fifteen hours in the covered stewpan in a warm place to maintain the temperature at 80° F. When the yeast is uncovered after fifteen hours' growth, the stock for the next growing is removed after gentle agitation of the stewpan to mix the settled yeast with the liquor.

The method of growing the yeast insures the absence of notable contamination of the wort with moulds or acid-forming bacteria. The aeration insures more rapid multiplication. It will be noted that the rate of multiplication of yeast cells in each growing is about ten times. Only in this way has it been possible to obtain a sufficient weight of yeast to ripen the dough in five or six hours. With less yeast in the sowing the final weight of yeast per gallon is less, though the rate of multiplication is faster. As far as the baker is concerned the practice in the bakehouse at the Technical College involves boiling the wort and its agitation with air.

In addition a careful study is being made of the conditions determining the greatest yield of yeast from a given quantity of wort. Attention has been paid to the effect of acidity upon the multiplication of the yeast cells. A systematic survey of recent investigations has been made to insure that notice may be taken of other facts discovered in different researches.

3. Pottery.—In the Report of the Executive Committee up to the 30th June, 1917, it was stated that certain questions relating to the clay industries had been referred to the Standing Committee on Chemicals, which was strongly of the opinion that measures should be taken—

- (a) To collect and co-ordinate the data on clays published by the various State Geological Departments, and to continue the work they have begun.
- (b) To encourage the establishment of schools of pottery.
- (c) To assist competent research chemists and physicists in carrying on ceramic investigations.
- (d) To induce manufacturers to produce the higher grades of porcelain ware, including domestic porcelain.

The chemical composition of clays does not give all the information required as to their value for the manufacture of pottery-ware, bricks, &c., and it is necessary that physical and practical tests should also be carried out. The general experience is that two clays may have practically the identical percentage of constituents present in chemical analysis, but that on applying the practical and physical tests, one may be a clay of good quality for certain manufactured articles, and the other of little or no value. Experts who have been consulted by the Executive Committee on the matter are of the opinion that the testing of clays, fire-clays, and cement material is a matter for a Federal Department to deal with, and that a Ceramic Department modelled on lines similar to those in the United States of America and Canada should be established in Australia.

A request was made to the Executive Committee for funds to carry on research work on **pottery, enamels, and glazes** at the Bendigo School of Mines and Industries, and thus also to establish the nucleus of a pottery school. The Executive Committee consulted Mr. J. R. L. Anderson, Director of the Bendigo School of Mines, on the matter, and suggested (a) that part of the necessary funds for the establishment of a school of pottery might be obtained by local contributions from persons interested in the pottery trade; and (b) that the research work might be carried out under the supervision of a Special Committee. The latter work would, of course, involve careful chemical analyses as well as practical trials of glazes and enamels, and could be carried out only by a specially qualified investigator. As no person possessing the requisite qualifications and experience was available, the Executive Committee was unable to proceed with the matter. As regards the proposal for the establishment of a pottery school, the Council of the Bendigo School of Mines has asked the Victorian Department of Education to provide increased accommodation and the necessary equipment for the establishment of such a school. The Executive Committee decided that if the requisite accommodation and equipment are provided, it will be prepared to favorably consider the question of co-operating by furnishing the necessary funds for the appointment of an expert to take charge of the analytical side of the work. The Committee was of the opinion that it would be a waste of money to make a grant for the purposes suggested until adequate accommodation and equipment are provided, and until a properly qualified expert can be obtained.

As regards the **collection of the data on clays** referred to in paragraph (a) above, the Chemicals Committee is collecting from the Mines Departments in each State all available information as to the extent, locality, and quality of clays and kaolins suitable for pottery purposes. The information thus collected will be collated, and will form the basis of consideration for the formulation of a comprehensive scheme of research.

The question of investigating the **pottery clays of Western Australia** was brought before the Executive in May, 1918, by the Western Australian State Committee, which reported that systematic experimental work on this matter had been commenced towards the end of the year 1917 by Mr. E. S. Simpson, B.Sc., B.E., Government Chemist and Mineralogist, Western Australian Department of Mines. The services of an expert potter to work under Mr. Simpson's direction had been obtained by the State Government, which had expended on the investigations up to June, 1918, a sum amounting to from £200 to £300. After discussing the matter with the Hon. R. T. Robinson, K.C., M.L.A., Minister for Industries in Western Australia, the Executive Committee decided to make a grant of £300, and thus to place the financing of the work on a £1 for £1 basis as between the State Government and the Advisory Council. The Executive appointed a Special Committee, consisting of Messrs. C. S. Nathan, A. Gibb-Maitland (Government Geologist, Perth), and E. S. Simpson to supervise the experimental work.

4. Engineering.—In the engineering industry the Executive has had systematic investigations carried out into two main problems. These are (a) the design and manufacture of internal combustion engines suitable for using alcohol as a fuel in place of mineral oils; and (b) the development of mechanical cotton pickers. The former problem involves also investigations, firstly, into raw materials from which alcohol can be manufactured commercially, and, secondly, into the question of denaturation. The latter problem necessitates investigations into varieties of cotton which are suitable for mechanical picking.

As regards the **production and utilization of power-alcohol** in Australia, the Special Committee appointed in March, 1917, continued its work during the year 1917-18, Mr. T. Baker and Dr. G. Harker, of Sydney University, having been added as members of the Committee. In January, 1918, a report by the Special Committee was published in the form of a Bulletin*, in which the whole position is exhaustively discussed. The subject is dealt with under three main heads, viz.:—(a) The production of alcohol; (b) the utilization of alcohol; and (c) the denaturation of alcohol. As regards the production of alcohol the whole question of the raw materials from which the spirit can be manufactured is comprehensively discussed, and the conclusion is reached that if some stimulus or inducement were offered for the manufacture of power-alcohol, there is a favorable opportunity for the establishment of a new and important industry in the Commonwealth. The experiments with alcohol engines at the Engineering Laboratory, Melbourne University, under the supervision of Mr. W. N. Kernot, have been continued, and the results obtained up to the end of the year 1917 set out in Bulletin No. 6. The question of denaturation has also been investigated, with a view to finding some substance which will fulfil the necessary conditions, and which will at the same time be cheaper than the denaturants at present used. The materials now in use for methylation under the *Spirits Act* 1906 result in an increase in the price of the spirit of nearly 2d. per gallon.

* See Bulletin No. 6, "Power-Alcohol: Proposals for its Production and Utilization in Australia."

The following recommendations of the Special Committee were adopted by the Executive, and transmitted to the Commonwealth Board of Trade :

- (1) That, in order to develop the use of alcohol for power purposes and to encourage the production of the raw material upon which the manufacture of power-alcohol depends, the necessary action be taken to allow of the manufacture and use in Australia of " power-alcohol " denatured with 2 per cent. of either—
 - (a) those fractions of coal tar oil distillates which are obtained at a temperature of from 170° C. to 230° C. ; or
 - (b) creosote oil, *i.e.*, such coal tar oil distillates as are specified above after they have been deprived of their tar acid contents.
- (2) That an allowance at the rate of 3d. per gallon be granted by the Commonwealth Government on " power-alcohol " denatured in the above manner and manufactured in Australia from raw materials produced in Australia, by way of reimbursement of the extra cost caused by fiscal restrictions on the manufacture of alcohol.
- (3) That a bonus, also at the rate of 3d. per gallon, be granted by the Commonwealth Government on such " power-alcohol " in order to encourage its manufacture and to develop the primary industries on which the supply of the necessary raw material depends.

A brief report of the work carried out by the Committee since the publication of Bulletin No. 6 is given in paragraph (i) hereafter. It may be mentioned that the investigations into power-alcohol have aroused considerable interest in various parts of the world, and that there has been a large demand for copies of the Bulletin both in Australia and in other countries.

As regards **mechanical cotton pickers**, it is pointed out on page 22 hereinbefore that the chief difficulty which prevents the successful establishment of the cotton-growing industry on a large scale in Australia is the high cost of picking by hand. This is due partly to inexperience, there being no body of skilled pickers familiar with the crop, and partly to the high rates of wages prevailing in Australia compared with other cotton-growing countries where coloured labour is available. Certain authorities in Queensland consider that the best way to overcome the labour difficulty would be to encourage farmers to grow small crops, say 10 acres, of cotton, in addition to other crops, and it is considered by these authorities that a family of four persons could easily pick the cotton produced on such an area without extra assistance. The introduction of an efficient mechanical cotton picker is, however, generally regarded as the most hopeful method of overcoming the labour difficulty.

After making inquiries from numerous sources and after taking steps to procure from America copies of all patent specifications relating to the matter, the Executive appointed a Special Committee in August, 1917, consisting of Mr. N. Bell, A.M.I.C.E. (Chairman), Consulting Engineer ; Mr. D. Jones, formerly cotton expert in the Queensland Department of Agriculture and Stock ; and Mr. P. L. Weston, B.E., Lecturer in Engineering in the University of Queensland. A grant of £250 was made for the experimental work, and the Senate of the University of Queensland kindly gave permission for the apparatus and appliances in the engineering laboratories to be made available for use in the experimental work.

The Special Committee, after examining various methods hitherto proposed and after carrying out a considerable amount of experimental work, has concluded that machine picking must be limited to certain tractable varieties of cotton, that is to say, varieties in which the calyx opens wide and the seeds are comparatively loose. Mr. Jones has visited various parts of Queensland to obtain seed of suitable varieties, and considers that a suitable type of cotton of equal value to the intractable types can be obtained. As regards the type of machine picker, previous inventions have usually been operated on the suction principle, similar to the working of a vacuum cleaner. The Committee has however, come to the conclusion that steam is likely to be not only more economical, but also more effective than air. A design for a machine has been got out as a result of the experimental work, and it is hoped that a test on a commercial scale will be carried out during the forthcoming season. The report of the Committee on the work carried out up to the 30th June, 1918, is given in paragraph (ii) hereafter.

The question of the shortage in Australia of **transformer iron** has been considered by the Executive Committee, which in May, 1918, appointed a Special Committee consisting of Mr. G. D. Delprat, Major A. J. Gibson, and Professor T. R. Lyle to report on the matter, and to make recommendations on the proposal to manufacture transformer iron in Australia.

The matter of the shortage of **tin plates** in Australia, especially for the purpose of manufacturing containers for various commodities, was also considered by the Committee. Tin plates consist of approximately 98 per cent. of steel and 2 per cent. of tin. Their manufacture involves

two distinct processes, viz.:—(a) The supply of steel and its manufacture into sheets; and (b) the supply of tin and the tinning of the sheets. The only difficulty in making the steel sheets lies in the supply of the powerful rolling mills required. The steel plates can be made available in Australia, while on the other hand in England the plant for rolling the plates is available, but sufficient steel cannot be obtained to keep the mills running. The tinning of the sheets does not offer any special difficulties, and there is no reason why the process should not be carried out in Australia, where the tin is produced. The Executive Committee accordingly recommended that the Commonwealth Government should offer inducements at an early date for the establishment of the industry in Australia. It is understood that steps are being taken to import the necessary rolling mills, and that the industry will be established in the Commonwealth before long.

(i) *Power-alcohol*.—Since the publication of the Bulletin, in which the various matters dealt with by the Special Committee up to the end of 1917 were exhaustively discussed, considerable progress has been made in the work of the Committee. Firstly, as regards raw materials for the manufacture of alcohol, additional information has been collected, and arrangements have been made for systematic experimental work regarding macrozamia and sorghum. Experiments with the former material are being carried out at Sydney University under the direction of Dr. G. Harker, assisted by Mr. Gilbert Wright, Miss Hindmarsh, and Mr. Shelton. Species of *Macrozamia*, which are commonly known as zamia-palms, burrawangs, or native pine-apples, are common in Australia and in certain localities, such as the coastal regions of New South Wales and Western Australia they often form a dominant element of the vegetation. The swollen stems of the plant contain a high percentage of carbo-hydrates. Analyses made by Mr. F. B. Guthrie, Chemist, Department of Agriculture, Sydney, of *Macrozamia spiralis*, show that the percentage of carbo-hydrates in the fresh material is 12·19 per cent., while calculated to dry substance the percentage is 66·97. It is not, however, known at present whether all these carbo-hydrates are fermentable. The object of the experiment which the Committee has initiated is to determine the fermentable contents of different species of macrozamia at various stages of growth and at various seasons of the year, and to ascertain whether there is any variation in the fermentable contents of the different parts of the stems of the plant. The New South Wales Forestry Commission is co-operating in the work by making the services of one of the forestry inspectors available to assist in obtaining specimens for analysis. The Forestry Commission is independently investigating the question of the cost of collecting the macrozamia stems, which is, of course, a most important factor in the commercial utilization of the material. It is understood also that the New South Wales Government has arranged for large scale experiments on the yield of alcohol obtainable from the macrozamia to be carried out by Mr. Grove Johnston at Narellan, New South Wales.

As regards sorghums, the Experiments Supervision Committee of the New South Wales Department of Agriculture has kindly consented to arrange for a series of experiments to be carried out at the Hawkesbury Agricultural College during the forthcoming season, the object of the experiments being to determine for different varieties of sweet sorghums and at different stages of their growth (a) the fermentable contents, and (b) the percentage of juice extractable. Experimental plots will be cultivated to ascertain the yield in tons per acre of topped sorghum cane, so that all the necessary data will be available to determine the yield of alcohol which can be obtained per acre.

As regards the engine problem, important progress has been made, particularly in respect to overcoming the difficulty of starting engines from cold on alcohol. A skilled mechanic has been engaged to assist in the experimental work which is being carried out under the supervision of Mr. W. N. Kernot at the Engineering Laboratory, Melbourne University, through the courtesy of Professor Payne. These experiments are not yet sufficiently advanced to justify the publication of the results attained.

The Committee is also experimenting with etherized alcohol as a fuel. A patent has been taken out for a liquid fuel consisting substantially of equal parts by weight of ether and alcohol, with a small proportion of ammonia, and a plant has been erected near Durban, South Africa, by the Natalite Motor Spirit Co. Ltd., at a cost of £60,000, to manufacture this fuel from sugar molasses. It is claimed that the fuel can be used in existing engines without alteration, and the Committee is carrying out experiments to test its efficiency and suitability to Australian conditions.

The Committee, being impressed with the serious shortage of methylated spirits in Australia and the danger of a serious diminution in the supplies of imported liquid fuels, passed the following resolution, which has been transmitted by the Executive Committee to the Commonwealth Board of Trade:—

“From information received, the Committee deems it imperative that the supply of industrial alcohol should be largely and immediately increased. The only way that the Committee sees whereby this could be done immediately would be by diverting a portion of the distilling plant now used for making potable spirits to the manufacture of industrial alcohol. Further, the Committee draws the attention of the Executive to the fact that the recommendations made in the Committee's Report of December, 1917,* if they had been adopted, would now in all probability be favorably affecting the situation.”

It should be mentioned that the work of the Committee has been seriously hampered by the fact that the Advisory Council has no laboratories in which experimental work on distillation and on various raw materials can be carried out.

(ii) *Mechanical Cotton Pickers*.—From examination of the conditions, it appeared that any attempt to produce a cotton-picking machine, which would depend for its action upon the positive contact of mechanical appliances to the cotton, would yield doubtful results, owing to the fact that the picking would not only be inefficient, but could not be carried out without damage to the trees. Several such arrangements were considered, but none offered sufficient possibilities to justify completing investigation. The disadvantages may be summarized as follows:—(a) The mechanical appliances would be bound to be complicated and liable to get out of order; and (b) as the pods vary in size the mechanical device would require some means of adjustment to the various shapes and positions of pods.

A system employing fluid under pressure, such as air or steam, appears to offer the best chance of success, consequently most of the experiments have been devoted to apparatus working under this system. It had previously been considered that machinery working on the vacuum principle, similar to a vacuum cleaner, would be most effective. In this a small quantity of fluid under pressure is used to displace a larger quantity, thus creating a partial vacuum

* These recommendations are given on page 47 hereof.

which might be capable of detaching the cotton from the pod. Another method considered was the combined principle of pressure and vacuum. In this the fluid under pressure is brought into positive contact with the cotton, which has been sucked in front of the jet by the action of the fluid as in the vacuum system.

(a) *Aspirator*.—Three different applications of the aspirator were experimented with. One of these was received from Mr. D. Jones, the other two were constructed by the Committee. In every case the vacuum produced was sufficient to convey the cotton along a tube to a receptacle, but only in some cases, and with particular types of cotton, was it sufficient to detach the cotton from the pod. On examining this principle as applied to intractable cotton, it became evident that to produce economically a vacuum powerful enough to complete the operation of picking, a vacuum pump would be required, and this introduced difficulties in connexion with the delivery of the picked cotton. Also to avoid excessive dissipation of the vacuum, some form of flexible mouthpiece would be necessary to accommodate the irregularity of the cotton bolls, which would probably make the application difficult and clumsy. Further, the action of the suction being in the nature of a pull on the top of the head of the cotton, would be most likely to detach the least resisting portion of the cotton, leaving an opening below, through which the inrush of air would reduce the power to deal with the more firmly attached part. These considerations point to a definite limitation of the vacuum principle to such types of cotton as are tractable.

(b) *Combined Principle*.—It was afterwards decided to try the combined principle of pressure and vacuum in connexion with intractable cotton. Several forms embodying this principle were constructed and tested, differing in design and details of jets. In order to gain the full advantage of the pressure from the jet in an application of this principle, it is necessary that the entrance should be large enough to accommodate the cotton head, and in order to maintain the advantage of the vacuum principle, viz., that the cotton should be sucked into the entrance, the jet should be arranged in such a position that while not actually impinging on the cotton, its power to create suction may be utilized. The action of the combined principle is intended to be twofold—(a) Sufficient vacuum should be provided to suck the cotton in front of the jet; and (b) sufficient power should be provided in the jet to complete the picking and discharge the picked cotton.

(c) *Consumption of Fluids*.—The possibility of the commercial application of the foregoing principles depends entirely upon the economical utilization of power as compared with the hand labour. Although the Committee have not lost sight of the fact that it might be possible to secure labour for machine-picking when it would be impossible to induce labour for hand-picking, it was also considered as a primary object of the investigation that the cost of machine-picking should be less than that of hand-picking. The following figures are taken as a base from which to commence investigations. Of course, if no limit is set to the quantity and pressure of the fluid, any type of cotton might be picked, but the results would not be within the commercial possibilities of cotton-growing. The following comparative costs are based on hand-picking data received from Mr. D. Jones:—

Average quantity picked for eight-hour day	..	..	..	..	150 lbs.
Average cost to pick 1 lb.	..	..	..	..	3d.
Number of pods to the lb.	..	..	..	..	90
Number of heads picked per minute	..	..	..	..	19
Cost of picking 150 lbs. of cotton	..	..	..	..	9s. 4d.

Using steam, and given water and fuel within easy reach, wages would be the principal consideration in machine picking. So that, if a machine operator is paid 9s. per eight-hour day, he would require to pick at least the same quantity as the hand picker to make the cost even. If, however, it were found necessary to use air taken from a compressor driven by an oil engine, the speed of picking would require to be very much higher to balance the cost.

Experiments were made by the Committee with different designs of jets and hand-pieces. The most suitable and efficient which was devised discharges $18\frac{1}{2}$ cubic feet per minute at 60 lbs. per square inch. This would require an engine of 3 b.h.p. Fuel consumption would be $2\frac{3}{4}$ gallons of kerosene per eight-hour day. Allowing 9s. for the operator, and assuming that the kerosene could be bought at 1s. 6d. per gallon, the running cost per day would amount to 13s. It will be noticed that this machine would require to pick one and a half times the quantity picked by hand to place it on the same basis—that is to say, about 30 heads per minute. This was considered a working limit of speed in picking, and it can easily be seen that an increased engine power would necessitate an increased picking speed to balance the cost.

Experiments with the jet and hand-piece referred to above showed that, using air at 60 lbs. per square inch (the wet pressure at which the aspirator would take the cotton), a vacuum of about 7 inches of water, equal to about 1 lb. per square inch, was obtained. The area of the entrance for the cotton was 1.227 square inches, thus, theoretically, an effort of $4\frac{1}{2}$ oz. was exerted on the cotton itself at a consumption of 35 cubic feet per minute. The area for jet was 0.01227 square inches, and using air at 60 lbs. per square inch, and assuming a pressure drop between the source of supply and the cotton of 20 lbs. per square inch, the total force of impact would be theoretically about $\frac{1}{2}$ lb. consumption of air, say, 18.5 cubic feet per minute. It will thus be seen that about twice the effort was obtained with about half the expenditure of power. It shows the economical working of the combined principle. In application, however, the aspirator has the advantage that it would be mounted with a power plant on the cart, and thus only the suction hose would require to be carried to the work. This is specially important in the case of the use of steam, the loss due to leakage and condensation would be low, also the weight to be carried by the operator would be less than in the combined arrangement.

(d) *Comparison of Steam and Air*.—A steam plant would be less expensive both in first cost and in upkeep. It would also be simpler to operate and less liable to breakdowns than an air plant. Losses due to condensation at supply pipe and at jet, where the cold air comes in contact with the steam, would be experienced, but these should not be a serious drawback. Considered from every point of view, the use of steam is recommended as likely to give the best results.

(e) *Conclusions*.—The Committee has reached the conclusion that machine-picking by the methods here described, indeed by any type of machinery, is limited to the tractable types of cotton. If, therefore, it can be arranged that cottons can be grown which would have the same commercial value as the intractable type, the consideration of a machine-picker to deal with the latter type would be unnecessary. Mr. Jones states that the tractable type of cotton can be grown at the same value as the other type—it is only a question of cultivation and seed.

The hand-piece should be made of wood and shaped on the outside to suit the hand. The entrance should be about $2\frac{1}{2}$ inches diameter, and the discharge about $1\frac{1}{4}$ inches diameter, where it connects with the discharge pipe having a easy tapering towards the entrance. The inside of the hand-piece should be shallow, leaving as little space as practicable after the cotton head has been connected.

The parallel bore jet of $\frac{1}{8}$ -inch diameter has given good results by this arrangement, the impact being concentrated on the centre of the cotton where it is most firmly attached to the pod. Two jets, having a total area equal to an area of $\frac{1}{8}$ inch, and having their central lines parallel with one another, have also given good results. Care must be taken, however, that they are not far enough apart to blow past the cotton. Provision should be made for fastening the hand-piece to the hand in such a position that the fingers are free to push aside leaves and branches in guiding the hand-piece to the work. The coupling-in between the hose pipe and the hand-piece should be arranged on a swivel, giving free movement to the hand-piece without twisting the hose. It would be advantageous if the hose were clipped to the operator's waist belt about three feet from the hand-piece to take the strain off the hand-piece when moving round the tree. The other end of the hose should be fastened to a basket mounted on a cart. Several baskets having a capacity of, say, 30 lbs. of cotton each, could be carried and deposited on the ground. When full, they would be collected at the same time.

The steam should be conveyed to the hand-piece from the boiler by flexible metal hose clipped at intervals to the discharge hose and fitted to the hand-piece with a small stock valve. The weight of the complete outfit would be about 500 or 600 lbs. The cost should be small. At the present time, of course, the values of all ironwork are inflated, due to the shortage, and the prices would not be a fair indication. In normal times the whole outfit could probably be constructed for about £50. It is quite possible that more than one hand-piece could be provided for use in each hand, or that two flexible hoses could work from one boiler.

(f) *Summary*.—Having got as far as the foregoing with the small experiments, we are of opinion that in order to demonstrate on a commercial scale whether this apparatus would be effective, a small number of acres should be grown with the trees planted in rows to facilitate the traverse of the boiler up and down, and that a small plant should be built on the lines suggested, and when the cotton is ready for picking this could be carried out under the supervision of some member of the committee. We think the money risked would be well spent in demonstrating whether our conclusions are correct, and, if they are correct, no doubt the appliance can be manufactured commercially at a much cheaper rate.

5. Miscellaneous.—A considerable number of applications have been received from manufacturers in regard to either the utilization of raw materials or processes of manufacture. These were generally not of such a nature as to necessitate experimental work, and they have been dealt with by the Executive Committee in many cases after reference for the advice and opinion of experts. Some of the more important of the matters dealt with are referred to in Part V. of this Report—"The Bureau of Information."

Closely connected with the shortage in Australia of tin plates referred to on page 47 hereinbefore is the question of devising satisfactory **substitutes for tin plates** for the manufacture of containers for a great variety of commodities. In October, 1917, the Director of Munitions reported to the Minister of Defence that, owing to the severe restrictions which it was imperative to impose on all manufacturers in Australia using tin plates, it was anticipated that, unless suitable substitutes are available, many factories in which it has been the custom to use tin plate for the packing of finished goods would be forced to close down. The matter was brought before the Executive Committee, which appointed a Special Committee to carry out experimental work into the whole question. The members of the Committee are Professor Masson (Chairman), Dr. Heber Green, and Messrs. R. J. Lewis and G. Ampt. Arrangements were made for the investigations to be carried out at the Department of Chemistry, University of Melbourne, and a grant of £50 was made each by the Executive Committee and the Department of Defence. The Minister of Defence arranged for the services of the Chemical Adviser to his Department to be made available to carry out the experimental work. The investigations have proceeded continuously since October last, and are now practically completed. A report on the results of the work is in course of preparation, and will be published in Bulletin form shortly. In the meantime, directions and specifications for making the containers and the synthetic resin varnish required for some of them have been distributed to a number of firms in the Commonwealth, and the methods recommended by the Committee have already been adopted by several manufacturers. A brief account of the work of the Committee is given in paragraph (i) below.

In order systematically to develop research work and the application of science to the industries of Australia, the Executive Committee in October, 1917, took steps with a view to **the establishment of industrial research associations** among the industries themselves. In the United Kingdom a fund of £1,000,000 has been placed at the disposal of the Department of Scientific and Industrial Research, and a scheme has been evolved in that country, after consultation with manufacturers and others, for this fund to be expended on a co-operative basis in the form of liberal contributions towards the income raised by voluntary associations of manufacturers established for the purpose of research. By this method the systematic development of research and the co-operation of science with industry will be carried out in the United Kingdom under the direct control of the industries themselves. All considerations point to the necessity for combination to this end. If the firms in an industry which are engaged in the production of similar articles, or if the firms engaged in different industries which make use of the same raw or semi-manufactured materials, will combine to improve those articles or materials the scheme in England provides for liberal contributions to a joint fund for that purpose. Under

this scheme the fund for each industry will be expended by a Committee or Board appointed by the contributing firms in that industry, and the results obtained will be available for the benefit of the contributing firms.

Being impressed with the importance and success of the scheme which has been adopted in the United Kingdom, the Executive Committee invited the Victorian Chamber of Manufactures to appoint a small Committee to discuss with the Executive the questions (a) of evolving some suitable scheme for Australia on the lines indicated; and (b) of introducing the scheme to the various associations affiliated with the Chamber. A Committee was duly appointed by the Chamber of Manufactures, and arrangements were made for a meeting to take place. In the meantime, however, the Prime Minister had convened a conference on the organization of commerce and industry, with the result that it was decided to establish industrial associations in connexion with the new Department of Commerce and Industry. The Executive Committee considered that it would be useless to endeavour to establish another set of associations, especially for research purposes, and has therefore abandoned the idea. The Committee hopes, however, that one result of the organization of the industrial associations by the Department of Commerce and Industry will be that the respective industries will be enabled more readily to state the scientific and technical problems which confront them, and that a stimulus will thus be given to the whole movement for the scientific development of industries in the Commonwealth.

The scheme which has been established in the United Kingdom is regarded by the Executive Committee as of great importance, and further particulars are given in paragraph (ii) hereinafter.

(i) *Tin Plate Substitutes*.—The Special Committee appointed to investigate the industrial position created by the shortage of imported tin plate and to test the possibility of employing substitutes in the manufacture of containers for all descriptions of commodities, commenced its inquiries towards the end of October, 1917. The investigation has been proceeding continuously along the following lines:—

- (a) The examination and testing of cardboard containers and of methods of making them impervious as suggested by persons interested in this question, or as in actual use in other countries.
- (b) Inspection of plant and machinery of manufacturers and users of tin-plate ware and cardboard products, with the special view to their adoption in the manufacture of cardboard containers.
- (c) The development of "Magramite" as a proofing agent for cardboard.

The earlier observations, together with a sketch of the lines of experimental work followed, were outlined in an interim report on 13th December, 1917, and, as the outcome of continued investigation, the Committee have made several recommendations, and have drawn up provisional specifications for the preparation of "Magramite" varnish and its use in the manufacture of containers not intended for foodstuffs.

The recommendations made by the Committee are as follow:—

- (a) Of the various materials suitable for the treatment of cardboard containers, some are more or less resistant to water, others to alcohol, turpentine, and oils; some, again, are not affected by a moderate degree of heat, whilst others are brittle, or, on the other hand, soft and devoid of mechanical strength. In short, the proofing material must be selected with due regard to the commodity to be packed.
- (b) For such foodstuffs as "tinned" meats, vegetables, preserved fruits and unsweetened condensed milk, which require to be hot-processed (i.e., subject to heat and pressure), it would appear certain that no material other than tin plate is suitable. The most rational method of overcoming the shortage of imported tin plates for these purposes is to manufacture tin plate in Australia.
- (c) Cardboard containers, impregnated with paraffin wax, can be used as receptacles for golden syrup and treacle. Such containers are suitable for wet foodstuffs which do not require to be filled hot, and for powders which require to be protected against ingress or egress of moisture, but not for watery products nor for such fluids as turpentine, kerosene, &c. Incidentally, it was pointed out that some inducement on the part of the Government appeared to be called for to stimulate further enterprise in the paper and cardboard industries, which would result in increased production.

Further experiments are approaching finality as to the suitability for such containers for jam, which requires to be filled in hot (though not hot-processed), and it would appear that if they are to be successfully handled and closed while the contents are hot, special attention must be given to the rigidity and workmanship of the cardboard containers, and to the impregnation with paraffin.

- (d) Paraffined containers are, however, useless for oily, spirituous or other preparations which attack the wax, and the most resistant-proofing material available for these is a synthetic resin (Magramite). Containers treated with Magramite have been proved to be satisfactory for paints, turpentine, kerosene, and methylated spirits.

The Committee has drawn up specifications both for the method of preparation of the synthetic resin varnish (Magramite) and for the manufacture of containers treated with Magramite. The varnish is now being manufactured in Melbourne, and inquiries have been instituted in other States with a view to the extension of its manufacture. Several firms are already manufacturing the board required for the containers. The Committee has received and answered a large number of inquiries on points arising out of the preparation of the varnish and the treatment of cardboard for special purposes, and the containers and processes recommended have already been adopted by a number of firms.

(ii) *Industrial Research Associations: Particulars of Scheme adopted in United Kingdom*.—Grants from the fund of £1,000,000 are made by the Department of Scientific and Industrial Research on a co-operative basis in the form of liberal contributions by the Department towards the income raised by voluntary associations of manufacturers established for research purposes. The fund for each industry is controlled by a Board appointed by the contributing firms in that industry, and the results obtained are available for the benefit of these firms. The Government contributions are promised for a period not exceeding five years, but may be extended. The contributions are made in

anticipation that when the new associations are once fairly launched, the need for direct State assistance will disappear. The method of assessing the subscription of each firm is determined by negotiation with each industrial organization, but the intention is that firms should contribute on a basis proportionate to their size. The contributions from the individual firms are recognised as business costs, and are not subject to income or excess profits taxation.

Each firm subscribing to a research organization under the scheme evolved in England has the following privileges :

- (a) It receives a regular service of summarized technical information which keeps abreast of the technical developments in the industry at home and abroad. To do as much for itself any firm would have to employ more than one man on its staff reading and translating the technical press.
- (b) It is able to obtain a translated copy of any foreign article in which it may be specially interested, and to which its attention will have been drawn by the periodical bulletin.
- (c) It has the right to put technical questions and to have them answered as fully as possible within the scope of the research organization and its allied associations.
- (d) It has the right to recommend specific subjects for research, and if the Committee or Board of the research organization of that industry consider the recommendation of sufficient general interest and importance, the research is carried out without further cost to the firm making the recommendation, and the results are available to all the firms in the organization.
- (e) It has the right to the use of any patents or secret processes resulting from all researches undertaken, either without payment for licences, or, at any rate, only nominal payment as compared with firms outside the organization.
- (f) It has the right to ask for a specific piece of research to be undertaken for its sole benefit at cost price, and, if the governing Committee or Board approve, the research will be undertaken.

It is obvious that capital, management, and science must have suitable representation on the Boards controlling the associations, but importance is attached in the British scheme also to the representation of the workers in the industries concerned. In this connexion reference may be made to the proposals contained in the Interim Report of the British Sub-Committee of the Reconstruction Committee on Relations between Employers and Employees (Cd. 8606), commonly known as the Whitley Report, which advocates the establishment of Standing Joint Industrial Councils. It is proposed in the latter Report that the National Councils should have power to allocate to District Councils the following questions :—

- (a) Industrial research and the full utilization of its results ; the provision of facilities for the full consideration and utilization of inventions and improvements designed by work-people, and for the adequate safe-guarding of the rights of the designers of such improvements.
- (b) Improvements of processes, machinery, and organization, and appropriate questions relating to management and the examination of industrial experiments, with special reference to co-operation in carrying new ideas into effect, and full consideration of the work-people's point of view in relation to them.

The scheme for the formation of Industrial Research Associations in the United Kingdom has already met with considerable success. The associations established include Cotton Manufacturers, Woollen and Worsted Manufacturers, Flax Spinners and Weavers, Shale-oil Industry, Photographic Manufacturers, Electrical Engineers, Aircraft Constructors, Shipbuilders, Iron Puddlers, Pianoforte Manufacturers, Master Printers, the Cocoa Industry, and Papermakers. Associations receiving grants must be approved and registered by the Board of Trade, and existing organizations are utilized, if practicable.

G.—STANDARDIZATION.

1. General.—In the Report of the Original Drafting Committee it was stated that “The highly specialized intricate work of standardizing electrical instruments and other scientific apparatus for use as sub-standards by different Government Departments and other institutions in which research work may be carried on would also naturally fall within the functions of the Institute.” The Executive Committee has accordingly collected information both from published documents and by personal interview with experts regarding the organization and work of standardization institutions in other countries, and has considered the probable requirements of Australia in connexion with this class of work. The Committee is of the opinion that work of this nature is not only of fundamental importance to Government Departments and scientific institutions, but would be highly beneficial, firstly, to consumers, in bringing about improvements in quality ; and, secondly, to producers, in the adoption of improved standard types and qualities, and of scientific methods of control of temperatures, pressures, measurements of time and space, chemical processes, and other technical factors which determine the amount and quality of the output of secondary industries. The recommendations of the Advisory Council in regard to the standardizing work of the future Institute have already been given on page 9.‡

Though it is probable that many of the standards which have been developed in Europe and America can be adopted in the Commonwealth, it will be necessary for investigations to be carried out in order to ascertain whether such standards are suited to Australian conditions. It is also important that some organization shall be established to act as an impartial authority in regard to referee work. The Committee considers that the work of standardization should be developed, so far as practicable, in close touch with industrial associations and other interested parties, as is done in the United States of America through the Bureau of Standards and the American Society for Testing Materials. Though it is obviously beyond the scope of the functions of the Executive Committee to institute any comprehensive scheme of standardization on the lines indicated above,

a beginning in this direction has been made in respect of the following matters, viz. :—(i) Standardization of analytical methods in the chemical industries; (ii) the appraisement of alcohol in spirituous liquors; (iii) the metric system and decimal coinage; and (iv) standardization in the electrical industry.

2. Standardization of Analytical Methods in Chemical Industry. About three years ago the Society of Chemical Industry of Victoria, in co-operation with various scientific, industrial, and commercial interests, formulated a scheme for a series of investigations with a view to determining standardized methods of analysis for use in the chemical industries. Other countries, notably the United States of America and Germany, have long since recognised the importance of standardizing analytical methods. Chemists in these countries have done much valuable work in testing methods and selecting those deemed most suitable for general adoption. In some instances methods investigated and recommended in this way are made binding by legal enactment. In Australia analytical methods are playing an increasingly important part in contracts between buyers and sellers of raw materials and manufactured products, for example, in the case of phosphatic rocks for the manufacture of fertilizers, and in the marketing of metallurgical products, such as lead and zinc concentrates and the useful metals. In these cases the detailed methods to be used in valuing the materials are ordinarily embodied in the contract. By the use of standard methods discrepancies between the results of various analyses are reduced to a minimum, and disputes, often involving much loss of time and money, are avoided.

The official methods of the United States Department of Agriculture have, up to the present, been largely employed in the Commonwealth for the analysis of agricultural and other products. But chemists in Australia are reluctant to adopt, without investigation, the methods recommended in other countries, especially in view of the fact that such methods are worked out under conditions and upon materials sometimes differing from those in this country. The scope of the work planned by the Society of Chemical Industry of Victoria in conjunction with other bodies may be summarized as follows :—

- (a) To review the best methods of analysis of materials.
- (b) To compare the standard methods of other countries.
- (c) To study the results of investigations made with those methods by various workers.
- (d) To conduct comparative tests on proposed methods.
- (e) To recommend methods for general adoption.
- (f) To keep in touch with all current work on analytical methods, and to report on new methods, and on old methods in the light of new research.

The work is being carried out gratuitously by members of the Society. The Executive Committee is of the opinion that not only will the direct results of the investigations be highly beneficial to industry, but that the work will engender among local chemists the habit of scientific research, and will assist in the training and formation of a body of skilled investigators. The Committee has accordingly made a grant of £50 to the Society for the purchase of materials, and for incidental expenditure connected with the investigations. The grant was made on the condition that the Society furnishes reports from time to time to the Executive Committee. Since the grant was made this work has been taken over from the Society of Chemical Industry of Victoria by the Australian Chemical Institute, an organization which extends to all the States, and the standardizing work has since been carried on by the Analytical Investigations Committee of the Institute. This extension of the organization on a Commonwealth basis will greatly facilitate the attainment of uniformity in analytical methods in the several States.

Up to the 30th June, 1918, five sections of the Analytical Investigations Committee had been formed. Particulars of their work are given in the following paragraphs (a) to (e). New investigational sections will be organized from time to time, wherever active workers are available. It is obvious that the details of the work of any one section must be controlled by one Committee meeting at one centre, though it may have corresponding members, and will require co-operative analysts to help in certain portions of the research.

Analysts who desire to take part in this important work, the first co-operative analytical research work organized under the auspices of the Australian Chemical Institute, are invited to get into touch with members of the Committee. The central organizing secretary is Dr. Heber Green, University of Melbourne.

(a) *The Fertilizer Section.*—A considerable amount of useful work has been done on both the determination of phosphoric acid and of alumina in rock phosphates. A method suggested by Dr. Campbell for the determination of phosphoric acid has been critically and experimentally examined by the members of this section, and the most suitable concentrations and other conditions necessary to obtain accurate results have been decided. Special samples have been prepared of a

high and a low grade phosphate and also of a pure calcium phosphate, and these are now ready for distribution to the co-operating analysts, who have promised to take part in the scheme for a comparison of this proposed method with the standard A.O.A.C. method (as used in Victoria) and the Lorenz method (as used in Brisbane). Mr. Thompson has suggested a new method for the determination of alumina in rock phosphate, which he and other members have been investigating. It is expected that this will supersede the unreliable methods at present usually adopted.

This section has also discussed the question of the commercial sampling of fertilizers, and has been in communication with a conference convened by the Under-Secretary for Agriculture, Queensland, which has made proposals for a uniform system of sampling.

(b) *Tar-products for Road-paving Section*.—This section held one very enthusiastic meeting, but for one cause or another it has not been found possible up to the present to meet again. Steps are being taken to expedite the work.

(c) *Baking Chemicals Section*.—Work is being actively proceeded with on the determination of "Available Carbon Dioxide" in baking powders. Meetings are held every few weeks, and the section hopes that it will shortly be in a position to recommend a new method for co-operative trial.

(d) *Non-ferrous Metals and Alloys Section*.—Three meetings have been held and methods for the estimation of impurities in copper and spelter have been critically discussed, with a view to the adoption of the methods best suited to local conditions. As in the other sections, literature published in the scientific journals and dealing with the points at issue is being reviewed and summaries distributed to members.

(e) *Malt Extract Section*.—This section was inaugurated at the last meeting of the Analytical Investigations Committee. It is proposed to deal with the estimation of the diastatic power, and to critically examine the Harrison and Gair method, which is at present the legal standard in Victoria.

3. The Appraisalment of Alcohol in Spirituous Liquors.—The question of altering the present complicated methods for the appraisalment of alcohol in spirituous liquors was brought under the notice of the Executive by the Victorian State Committee. Under the existing system alcoholic liquors are valued in terms of "Proof spirit," which by legal enactment in Australia is spirit of specific gravity 0.9198 at a temperature of 60° Fahr. It is thus possible to have spirit of over 100 per cent. proof strength—a paradoxical and confusing situation. The "Proof spirit" standard is an obstacle in the way of the application of science to industry and could easily be replaced. The Victorian Committee proposed that the "Proof spirit" standard be abolished, and that valuation in terms of absolute alcohol by weight be substituted. Copies of the resolutions embodying the proposal made by the Victorian Committee were forwarded by the Executive to the other State Committees. The Committees in New South Wales, South Australia, and Western Australia approved of the proposals, but the Queensland State Committee, though in agreement as to the desirability of reform, adopted a series of modified resolutions.

The proposals of the Victorian and Queensland State Committees were communicated by the Executive to the Department of Scientific and Industrial Research, London, with a request for an expression of the views and the advice of the Department on the suggested reform. The Executive was informed that the Advisory Council in England agreed that the existing method of appraisalment was admittedly unscientific, and that the Executive's memorandum had been forwarded to the Board of Customs and Excise, which consulted Sir James Dobbie, the Government Analyst, on the matter. Sir James Dobbie stated that the present system of expressing the alcoholic content of spirituous liquors is admitted on all hands to be unscientific and inconvenient. He considered, however, that any change would introduce temporarily great confusion into the fiscal and commercial systems, and for that reason he deprecated raising the question for the present. He stated, moreover, that neither the Customs authorities nor business firms are in a position at the present time to give mature consideration to the many changes which would be involved by the introduction of a new standard. The Executive Committee has accordingly decided to take no further action in the matter for the present.

4. The Metric System and Decimal Coinage.—The war has shown that if the British Empire is to hold its own in the commercial competition of the future, certain reforms in its business and commercial methods must be made. Prominent among these are questions relating to weights and measures and currency. The defects of the existing systems, and the inconveniences they cause, both in regard to domestic trade and industry and to international relations, are too well known to require explanation in this Report. In so far as the matter immediately concerns the

functions of the Executive Committee and of the proposed permanent Institute, it may be pointed out that the introduction of the metric system of weights and measures and of the decimal system of coinage is of importance both in respect to scientific and technical education and in the application of scientific methods to industry. It is believed that the present time, when the public mind is prepared to accept changes that might at ordinary times be unacceptable, may be opportune for the introduction of such systems in the United Kingdom and the Dominions.

The Executive have accordingly taken action in the matter in several directions. In the first place they communicated with the Department of Scientific and Industrial Research, London, asking for an expression of their opinion on the proposal to introduce the desired changes. They were informed that the British Department did not contemplate taking any action in the matter, that the Government Committee on Trade Policy after the war, under the chairmanship of Lord Balfour of Burleigh, would probably take evidence on the subject at an early date, and that the communication received from the Executive had been commended to the careful attention of Lord Balfour of Burleigh's Committee.

The Executive appointed a Standing Committee consisting of Professor A. D. Ross and Mr. F. W. Barford, M.A., A.I.A., to make inquiries and report on the matter. The final Report of Lord Balfour of Burleigh's Committee on Trade Policy after the war has been received, and the Committee is strongly unfavorable to the compulsory decimalization, at any rate at present, of weights and measures and coinage. The Special Committee appointed by the Executive is of the opinion that, in view of the Report of Lord Balfour's Committee, it is inexpedient to propose any action in Australia at the present time. It suggests, however, that it should be retained to watch and report on any developments in the near future.

It has been pointed out that while Lord Balfour's Committee was a large one, it contained only one person who was in a position to speak on behalf of the scientific community, and it is understood that there is a feeling that the Report will not be the last word on the matters of Units and Coinage. Indeed, a Decimal Coinage Bill has been introduced into the House of Lords, and, while it is believed that there is practically no chance of a private member's Bill going through at the present time, it indicates the strong feeling in the country, due to the unanimity of the views of the Institute of Bankers, the Association of Chambers of Commerce in the United Kingdom, and the Decimal Association.

(i) *First Report of Standing Committee on Decimal Weights and Measures and Coinage.*—After the appointment by the Executive of the Standing Committee on Decimal Weights and Measures and Coinage, steps were taken to keep in close touch with Lord Balfour of Burleigh's British Committee on Commercial and Industrial Policy after the War. This Committee was appointed by Mr. Asquith in July, 1916. Professor Ross, when in London in the beginning of 1917, had an opportunity of discussing the question of Metric Units and Decimal Coinage with Lord Balfour (the Chairman), and had been asked to submit a statement of his views on some of those questions, particularly as they concerned the Australian Commonwealth. A communication received towards the end of 1917 from Lord Balfour made it appear very unlikely that the Home Government would at the present make any change either in measures or in coinage. Several advices were received from time to time, and finally a preliminary draft of the British Committee's Report. As no report had so far been made to the British Parliament, the communications were accompanied by strict injunctions that they were to be kept private until the inquiries had been completed and the Report had been presented. As a result of these communications, the Standing Committee felt that it would be inadvisable to undertake any extensive inquiries throughout the commercial, industrial, and scientific communities of Australia. They have, however, satisfied themselves from their investigations that a change of units would be much simpler in Australia than in older countries, that it would not involve a heavy cost, and that it is favoured by a large section of the people, provided that the simultaneous change is made throughout the Empire, or, at least, in the Mother Country.

Lord Balfour's Committee has now submitted its final report, which is strongly unfavorable to the compulsory decimalization, at least at the present time, of our weights and measures and our coinage. The following summarizes the views set forth:—

(a) *Decimal Weights and Measures.*—Lord Balfour's Committee considers that the time taken to complete a change to a new system of units has frequently been under-estimated, and expresses grave doubts as to whether certain of the old units would ever disappear. It considers that the difficulties in the case of the Textiles Trade (which before the war accounted for 30 per cent. of the British manufactured articles of export) are such as might jeopardize British supremacy in this trade. The Committee states that it recognises that many of the self-governing Dominions of the Empire are in a position to change without much difficulty to a compulsory metric system, but it feels that there would be very great difficulties in India and in the Crown Colonies and African Protectorates. As more than half of the British export trade before the war was with non-metric countries, the Committee feels that Great Britain could not possibly make the change unless it was also made simultaneously in the United States and Russia. The Committee has satisfied itself that the United States will not make the change at present, and is accordingly convinced that to make the metric system compulsory at the present time would not only fail to assist the re-establishment of British trade after the war, but would seriously hamper it. The Committee likewise considers that any attempt to decimalize the whole system of existing British units would be inexpedient at this time, but urges the abandonment of little-used units, the using of decimal subdivisions of our basic units, and the replacement wherever possible of the present hundredweight and ton by the cental of 100 lbs. and the "short ton" of 2,000 lbs. respectively.

(b) *Coinage*.—Lord Balfour's Committee considers that the most practicable proposal for a decimal currency is that supported by the Institute of Bankers, the Association of Chambers of Commerce of the United Kingdom, and the Decimal Association. The scheme is to divide the sovereign (which remains unchanged) into 10 florins and 1,000 mils. The Committee reports that the scheme would offer considerable conveniences in account keeping, especially in the case of banks and large commercial firms, but it would not promote either the unification of the existing coinage systems of the British Empire or the adoption of an international currency. The Committee considers that the crux of the question is the alteration of the value of the penny, and, having regard to the magnitude of the disturbance which this change might make in the lives of the great body of wage-earners, retail shop-keepers and their customers, is satisfied that the introduction of such a change would be inexpedient at a time when the social, industrial, and financial organizations of the country will be faced with numerous and exceptional difficulties.

In view of the Report of Lord Balfour's Committee, the Standing Committee is of opinion that it is inexpedient to propose any action here at the present time, but suggests that the Committee should, however, be retained to watch and report upon any developments in the near future (a private Bill on Decimal Coinage has been introduced into the House of Lords). In particular, it will be advisable to see whether the recommendations regarding the hundred-weight and cental, and the ton and short ton, are adopted in Britain, and to consider whether such adoption could be more quickly extended to Australia by legislation or by any action of the Advisory Council. The Committee, however, considers it inexpedient to take at present any action beyond emphasizing the importance of the British Committee's recommendations as to the value of employing decimal subdivisions of our basic units.

5. Standardization in Electrical Industry.—The Executive Committee received a communication from the Electrical Association of Australia stating that they are appointing a standing sub-committee, comprising members in New South Wales and Victoria, to investigate the present position in regard especially to the lack of uniformity in the systems for the generation and distribution of electrical power and to make recommendations for its improvement. The Executive consider that this work is highly important, and have appointed Mr. F. Leverrier, K.C., to act as their representative on the New South Wales section of the sub-committee, and Professor T. R. Lyle, M.A., Sc.D., F.R.S., to act on the Victorian section.

The Electrical Association drew the attention of the Executive to the disabilities which the absence of recognised standards impose upon the electrical industry in Australia. In the first place there is no uniformity in the voltage of the alternating current supply in the capital towns, while the direct current voltages of the smaller country supply stations is almost as varied. As regards periodicity, the eastern States have adopted 50 periods for general work and 25 periods for railway work, while the new Western Australian Government scheme at Perth is 40 periods. Further, there are no Australian standards for voltage of transmission lines, for voltage of generation, or for transformer ratios, nor are there any standards accepted in this country with regard to system of distribution, or for the rating of electrical machinery. This lack of uniformity imposes a serious and artificial handicap on the development of the electrical industry in Australia. Not only does the multiplicity of systems involve locking up of large amounts of capital in stocks, but it greatly adds to the difficulties of "linking up" and militates against the progress of local manufacture. The indirect effects in hampering development in the supply of cheap electrical energy are also serious. If, on the other hand, electrical systems in Australia were standardized, local manufacturers could standardize their designs and by means of quantity production supply at lower prices. Standardization in the direction indicated must necessarily be of somewhat slow growth, since a complete scrapping of existing non-standard plants and their immediate conversion to a standardized system would involve too great an expenditure of capital.

The Committees in New South Wales and Victoria have first given consideration to the question of standard frequency, and have agreed to the following resolution:—

"That it be recommended that the standard frequency for alternating current supply shall be 50 cycles, provided that a frequency of 25 cycles may be used for special industries for which the advantages of the lower frequency are such as obviously to outweigh other considerations, and that the Committee further resolves that in the event of legislation being passed to carry into effect the above resolution, the enactment should make provision for the appointment of the Federal Council of the Electrical Association of Australia or the Council of the Institution of Engineers of Australia as an independent authority to receive and deal with applications for permission to use the lower frequency."

PART V.—THE BUREAU OF INFORMATION.

1. General.—In the original Report of the drafting Committee in January, 1916, on the constitution and functions of the proposed Institute, the Council were recommended to establish a Bureau "for the collection of industrial scientific information and its dissemination." As mentioned in the Report to 30th June, 1917, as a first step in this direction the Executive Committee appointed a Science Abstractor. The primary work of the Abstractor has been the preparation of reports and abstracts for the immediate use of the Executive, in connexion with new matters

or projects brought before them. In a number of cases the reports so prepared have been communicated to the persons originating the project, and in certain cases they have also been communicated to the press, sometimes in a somewhat modified form, as being likely to prove of general interest. In addition the Science Abstractor has prepared for distribution to the press summaries of progress reports received from time to time from Special Committees.

2. Library.—An efficient Bureau of Information will necessarily require an up-to-date library of technical and scientific books. A small commencement has been made in the direction of forming such a library, and new books on these subjects which receive favorable reviews in reliable journals are being obtained as a nucleus. In addition to books, a number of the leading technical journals are received or have been ordered. Most of these are being supplied in exchange for the publications issued by the Advisory Council. A list of those received up to June, 1918, appears below, but arrangements have already been made for the supply of many others.

All journals and publications received are carefully gone through, and all articles published in them dealing with science or technology are indexed for future reference. The index thus formed has already proved of service on numerous occasions when requests have been received for information.

(i) *List of Periodicals received by the Executive Committee:—*

(a) *General Science and Technology—*

Nature.
Scientific Australian.
Reports of Australasian Association for the Advancement of Science.
Proceedings of the Royal Society of Victoria.
Transactions of the Royal Society of South Australia.
Papers and Proceedings of the Royal Society of Tasmania.
Proceedings of the Linnean Society of New South Wales.
Journal of the Royal Society of Arts.
Journal of the British Science Guild.
New Zealand Journal of Science and Technology.
South African Journal of Industries.

(b) *Chemical and Mining—*

Journal of the Society of Chemical Industry.
Journal of Industrial and Engineering Chemistry.
Chemical, Engineering, and Mining Review.
Industrial Australian and Mining Standard.
Australasian Journal of Pharmacy.
Chemist and Druggist of Australia.
Bulletin of the Institution of Mining and Metallurgy.
Review of Mining Operations in South Australia.
Journal of Chamber of Mines of Western Australia.

(c) *Agriculture and Forestry—*

International Review of the Science and Practice of Agriculture.
International Review of Agricultural Economics.
Australian Farm and Home.
Pastoral Review.
Agricultural Gazette of New South Wales.
Journal of the Department of Agriculture of Victoria.
Queensland Agricultural Journal.
Journal of Agriculture of South Australia.
Australian Sugar Journal.
Australian Forestry Journal.
Jarrah.

(d) *Physics and Engineering—*

Bulletin of United States Bureau of Standards.
Commonwealth Engineer.
Proceedings of Victorian Institute of Engineers.
Illuminating Engineer.

(e) *Manufactures—*

Australasian Manufacturer.
Journal of Leeds University Textile Association.

(ii) *List of Public Departments, Institutions, and Societies from which Reports, Bulletins, or other Documents have been received:—*

(a) *Australia—*

Commonwealth Parliament.
Commonwealth Bureau of Census and Statistics.
Inter-State Commission.
Home and Territories Department.
New South Wales Department of Agriculture.
New South Wales Department of Mines.
Technological Museum, Sydney.
Queensland Department of Agriculture and Stock.
Queensland Department of Lands, Forestry Division.
Queensland Bureau of Sugar Experiment Stations.
Queensland Department of Mines.
South Australia Department of Mines.
South Australia Department of Chemistry.
Western Australia Department of Woods and Forests.
Tasmania Department of Mines.

(b) *British Empire—*

United Kingdom Department of Scientific and Industrial Research.
Dominions Royal Commission.
Development Commission.
Colonial Office.
Canada Department of Mines.
South Africa Industries Advisory Board.
Rhodesia Munitions and Resources Committee.

(c) *Foreign—*

International Institute of Agriculture.
United States Department of Agriculture.
United States Department of Commerce.
United States Bureau of Standards.
University of Illinois Engineering Experiment Station.
University of Illinois Agricultural Experiment Station.
University of Wisconsin.
Argentina Agricultural Museum.

3. Commonwealth Catalogue of Scientific Periodicals.—The lack of catalogues of the scientific periodicals in Australian libraries makes it impossible to ascertain whether a reference which it is desired to consult, but which is not available in Melbourne, is available in any other city of the Commonwealth. The Executive therefore decided to take steps to compile a catalogue of scientific and technical periodicals in all the public and semi-public libraries of Australia. A series of directions for the compilation of the necessary information on a uniform plan was drawn up by Messrs. E. La T. Armstrong, Chief Librarian, Melbourne Public Library, and W. B. Alexander, and arrangements were made through the State Committees for the carrying out of the work in

each of the States. Complete returns have been received for the libraries in Tasmania and Western Australia, and the work has made good progress in the other States, the cataloguing of the Melbourne and Sydney Public Libraries, and of the Mitchell Library, Sydney, being completed. Mr. E. R. Pitt, Chief Cataloguer of the Melbourne Public Library, who is engaged in preparing the catalogue for libraries in Victoria, is checking the cards received from the other States to insure uniformity and incorporating them in a common card catalogue. This catalogue should be of great service to scientific workers throughout Australia, as it will only be necessary to communicate with the Bureau of Information in order to ascertain the nearest library in which any particular journal can be consulted.

4. Publications. During the year the Executive Committee has published the following :—

- Bulletin 1. *The Cattle Tick in Australia* : being the Report of a Special Committee appointed to review the whole position of the Tick Pest, present and future, and make recommendations both as to future scientific research and as to immediate remedial or preventive measures, whether by legislation or otherwise.
- Bulletin 2. *Worm Nodules in Cattle* : containing (1) The Report of a Special Committee appointed to inquire into the Nodule Disease in Cattle, and to make recommendations as to a Future Plan of Research; (2) The Occurrence of Onchocerciasis in Cattle and Associated Animals in Countries other than Australia; (3) Bovine Onchocerciasis in South America; (4) Further Investigations into the Etiology of Worm-nests in Cattle due to *Onchocerca gibsoni*; (5) Investigations into the Cause of Onchocerciasis in Cattle conducted in the Northern Territory.
- Bulletin 3. *The Alunite Deposits of Australia and their Utilization* : being the Report of a Special Committee appointed to investigate the Australian deposits of Alunite and their suitability for the production of Potash.
- Bulletin 4. *The Factors influencing Gold Deposition in the Bendigo Gold-field* : being the Report of Dr. F. L. Stillwell's Investigations into Gold occurrence on the Bendigo Gold-field.
- Bulletin 5. *Problems of Wheat Storage* : containing (1) the Report of the Committee appointed to investigate the effect of Quicklime on Wheat; (2) Summary of Reports received from the Government Entomologists of the Australian States as to Insects damaging Grain; (3) Progress Report of Special Committee on the Damage to Stored Grain by Insects.
- Bulletin 6. *Power Alcohol : Proposals for its Production and Utilization in Australia* : being the Interim Report of a Special Committee on Alcohol Fuel and Engines.
- Bulletin 7. *Agricultural Research in Australia* : being a Report of the Proceedings at a Conference of Agricultural Scientists held in Melbourne, 9th to 16th November, 1917.
- Pamphlet 1. *Recent Developments in the Organization of National Industrial Research Institutions* : by Gerald Lightfoot, M.A.
- Resolutions passed by the Advisory Council, July, 1917, together with Report and Recommendations on the Organization and Work of the Proposed Permanent Institute of Science and Industry.*

These publications have been widely circulated to Public Departments, Libraries, Societies, and individuals in Australia and abroad, and notices have been published in most of the newspapers of the Commonwealth, drawing the attention of the public to the fact that they were obtainable free on demand. As a result, a large number of requests have been received for some of the bulletins, and most of them are in frequent demand. Bulletins on a number of other subjects are in course of preparation. The Science Abstractor is acting as Editor of the Bulletins.

5. Supply of Information. Requests for information on a great variety of topics have been received during the year. In some cases the request can be met by forwarding one of the bulletins published by the Executive or an abstract on the subject previously prepared by the Science Abstractor. In other cases the Secretary and the Science Abstractor have been able to supply the necessary information without reference to the Executive. In many cases, however, such requests have been considered by the Executive and either referred to one of its members with special knowledge of the particular topic to prepare a reply or referred to the appropriate Standing or Special Committee for a draft reply, which has subsequently been sent out in the name of the Executive.

Apart from requests for information received from private individuals, a number of requests have also been received from Commonwealth Departments, especially the Department of Defence. A number of requests for scientific information received by Commonwealth Departments have also been referred to the Advisory Council, and it would appear that the value of the Council as a scientific adviser to the Commonwealth Government is becoming more appreciated.

Some of the matters thus brought before the Advisory Council have already been referred to in previous sections of this Report, for example, the possibility of manufacturing aluminium in Australia, substitutes for tin-plate, the best season for felling timbers, &c.

Amongst other matters with which the Executive has dealt have been :

- The possibility of utilizing banana fibre ;
- The manufacture of cattle-food from bagass ;
- The possibility of the transmission of disease by mice-infested wheat ;
- The fertilizing effects of sulphur ;
- Milling tests for flour ;
- The utilization of powdered fuels ;
- The properties of Papuan gums and resins ;
- The utilization of leather-shavings for the manufacture of leather-board ;
- The manufacture of pemmican ;
- Electrical methods of prospecting for ores ;
- The prospects of cultivating the rice-paper plant ;
- The utilization of power from solar heat ;
- The restrictions imposed by postal regulations on the distribution of scientific literature ;
- The extraction of rubber from native rubber-vines ;
- The storage of wheat in sand ;
- Sericulture ;
- The use of limestone and gypsum for the manufacture of building slabs ;
- The construction of wheat silos.

On all the foregoing matters the Executive has collected information, and after considering it has either passed it on to the inquirer, or has made recommendations to the authorities concerned.

PART VI.—THE WORK OF THE STATE COMMITTEES.

The following Reports have been furnished by the several State Committees at the request of the Executive :—

1. New South Wales.—Seventeen meetings of the New South Wales State Committee have been held during the year ended 30th June, 1918. No change has taken place since last Report in the arrangements for conducting the business or in the *personnel* of the Committee, except that Professor J. D. Stewart automatically became a member on his election to the Executive, and he has attended our meetings regularly since his return to Sydney, in November, 1917. Professor R. D. Watt has continued to act as Hon. Secretary to the Committee. As in the previous year, a considerable proportion of the activities of the Committee have been connected with the collection of information for the Executive about matters which more particularly concern the State of New South Wales. Reports on the following subjects were prepared and duly submitted to the Executive, viz., local investigations in connexion with paper-making materials ; tin-plate and tin-plate substitutes ; the occurrence, distribution, and analysis of the *Zamia* palm ; the ceramic industry in New South Wales ; and the training of Australian students and apprentices in Great Britain.

At the request of the Executive our Committee had an interview with Mr. T. G. Adamson, of Tamworth, with reference to the possibility of growing and manufacturing in Australia a number of products of which there is a present or prospective shortage owing to freight difficulties. A number of these had already been considered by the Advisory Council or the State Department of Agriculture, and the Under-Secretary for Agriculture gave Mr. Adamson an assurance that his Department was willing to conduct trials of any others which offered any prospect of commercial success.

In connexion with the preparation of a Catalogue of Scientific and Technical Literature, the Committee recommended that the work, as far as New South Wales is concerned, should be carried out under the direction of Mr. Ifould, Principal Librarian, Public Library, Sydney, at a cost of £100, and this recommendation was adopted.

The Committee nominated a number of gentlemen to act as a Special Committee to report on Tuberculosis in cattle and pigs. This Special Committee has held several meetings, and is expected to issue an exhaustive report on the subject at an early date.

(i) *Drying of Sheep Skins.*—The attention of the State Committee was directed to the large annual losses through faulty drying and general treatment of sheep skins sent to Sydney from country districts. The desirability of a systematic investigation of the effects of sun-drying, shade-drying, and the use of various antiseptics was urged by Mr. F. A. Coombs, with whom the Committee had two interviews. Mr. J. W. Matthews, Sheep and Wool Expert, Department of Agriculture, furnished a report on the subject, and it was decided to ask him to conduct the necessary experiments—the variously treated skins to be submitted to a tanner for report.

(ii) *Cold Storage Problems.*—The Committee had an interview with Mr. W. J. Williams, Manager of the Municipal Cold Storage Works, Sydney, who brought under notice a number of problems in connexion with cold storage, and suggested that experiments should be undertaken to ascertain the best methods of treating various foodstuffs in order to minimize the losses which occur at present. A report on the subject was prepared by Mr. Williams and submitted to the Executive, with a request from the Committee that the matter should receive careful consideration. As a result, a Special Committee was appointed by the Executive with a view to acquiring accurate information based on experience, and devising and carrying out experiments to settle doubtful points.

(iii) *Tanning Problems.*—The Second Progress Report of the New South Wales Tanning Committee was considered, and representations made to the Executive for the renewal of the grant for another year. The difficulty of obtaining a supply of locally-tanned leathers suitable for book-binding was brought under notice by the Librarian of the Public Library, who drew special attention to the suitability of kangaroo skins for this purpose. At the suggestion of our Committee, Mr. F. A. Coombs arranged to carry out an investigation, involving the treatment of kangaroo and other skins by special tanning processes, samples of the finished leather to be submitted to the Librarian for report.

(iv) *National Economy Exhibition.*—A large diagram, prepared under the direction of the Committee, showing the losses incurred through various pests in Australia which are being investigated by the Advisory Council, was given a prominent place at the National Economy Exhibition held at the Town Hall, Sydney, in November, 1917.

(v) *Report of National Industries Committee.*—Arising out of a suggestion that a systematic study be made of the list of imports into New South Wales, attention was drawn to a report made to the Premier by the National Industries Committee, which did a good deal of work along similar lines soon after the outbreak of the War. Copies of the Report were obtained and circulated amongst the members. It was felt that, owing to a probable early change in the status of the Committee, nothing further could be done in the way of continuing the general inquiry work of the National Industries Committee. At the same time, there were three matters arising out of the Report about which it was thought action might be taken immediately, viz., (a) forestry research; (b) the branding of stock; and (c) the establishment of Industrial Research Fellowships. Representations were made to the Minister of Lands to have the Forestry Act amended so as to enable part of the revenue of the Forestry Department to be spent on research work—a suggestion which the Minister heartily indorsed, and promised to have carried out at an early date. An assurance was also given that the loss of skins through branding would be greatly reduced when the proposed Brands Act comes into operation. In connexion with the establishment of Industrial Research Fellowships, the Executive was urged to see that this important matter should not be overlooked, but should receive special consideration when the permanent Institute is established.

(vi) *Motor Spirit from Shale Oil.*—The attention of the Committee was directed to the possibility of increasing the yield of "motor spirit" from the shale oil deposits of New South Wales by means of one or other of the "cracking" processes recently developed in England and America, and this is still under consideration. There seem to be many difficulties in the way; but anything which will lessen the danger of a shortage of motor fuel is worthy of very serious investigation at the present time.

2. Victoria.—In view of the facts that the bulk of the work for which the State Committees of the temporary organization were established had already been completed in Victoria, and that a number of matters arising in that State were attended to by the Executive Committee, only one meeting of the Victorian State Committee was held during the year 1917-18. Practically no work has therefore been done by that Committee during the period under review.

3. Queensland.—During the year Mr. J. B. Henderson has acted as Chairman owing to the continued absence of Professor A. J. Gibson, and Dr. H. C. Richards has continued to act as Hon. Secretary. The members of the Committee have been called together approximately once a month to discuss the various subjects which come under consideration. In July, 1917, Mr. Norman Bell was appointed in place of Mr. Robinson as an Associate Member of the Advisory Council. In September Mr. G. E. Bunning resigned his membership, and his successor's appointment has not yet been gazetted.

The following are the main subjects which have been dealt with by the Committee:—

- (i) *Tuberculosis in Stock.*—The Report of the work of the Special Committee on Tuberculosis was distributed in Queensland through the Department of Agriculture and Stock.
- (ii) *Chair of Economic Biology.*—Efforts have been made to establish a Chair of Economic Biology in the University of Queensland, but so far these have proved unsuccessful.
- (iii) *Prickly Pear.*—Although this is one of the most important economic problems in Queensland, the State Committee has not yet been authorized to take any action.

- (iv) *Paper-pulp*.—The question of utilizing sugar-cane refuse for paper-pulp has been inquired into, and much assistance has been gained by reports, &c., on the matter from Mr. N. W. Jolly (late Director of Forests), and Dr. A. J. Gibson. After thoroughly considering the question, it was decided that it would be inadvisable to proceed further with investigations for utilizing sugar-cane refuse for paper-pulp. Other investigations have been inquired into with reference to certain soft woods in Queensland suitable for paper-pulp. The Committee interviewed Mr. Joseph Campbell, Cairns, regarding his investigations *re* paper-pulp, dyes, &c., and a report on his work was received.
- (v) *Catalogue of Scientific and Technical Literature*.—Arrangements have been made for the Catalogue of Scientific and Technical Literature, compiled by the Royal Society of Queensland, to be copied in the Brisbane Office. Further information is being obtained from certain libraries in Brisbane for inclusion in the catalogue.
- (vi) *Blow-fly*.—Much work has been carried out in the investigation of Blow-fly with the aid of the officers of the Department of Agriculture and Stock. As a result a Special Committee has been appointed in Queensland for this work, and a grant of £500 has been approved for carrying out the scheme of work drawn up for Queensland.
- (vii) *Sponge-fishing*.—Certain negotiations have been carried out with the State Government *re* obtaining the use of a boat and crew for the investigations to be carried out in the Cooktown District, in connexion with the sponge industry, but these were not successful owing to the Government having no boat available at that time.
- (viii) *Miscellaneous*.—A large amount of correspondence has been received from investigators, &c., requesting information on various subjects. These have been dealt with accordingly. Many other subjects have been dealt with by the Committee, viz., Camphor, Arsenic, &c.

Owing to the increasing work of the Queensland Committee, it was considered necessary in September last to have a permanent clerk solely on the work of the Queensland Committee of Science and Industry, also a technically-trained assistant to give part-time services. The clerk, Miss Todd, who was joint clerk to the Advisory Council of Science and Industry and the State Munitions Advisory Committee, was recommended as suitable for the position, and this recommendation was finally approved by the Prime Minister's Department.

4. South Australia.—The Committee continued to hold meetings at such intervals as were found necessary during the year. As pointed out in the previous Report, the existence of a Department of Chemistry and a Committee on Scientific Research appointed by the State Government renders it desirable to avoid overlapping in regard to the operations of the State and Federal organizations. So far no difficulty in this respect has been experienced. Researches have been carried out by the University and Department of Chemistry, and the results have been made available to the Executive Committee in the form of Bulletins and otherwise.

The immediate work of the Committee has been more in connexion with the obtaining of information which did not involve practical scientific investigation. During the year the Industrial Census of the State which had been completed by the Government Statist, at the request of this Committee, was received and forwarded to the Executive Committee. Information on technical matters was given to inquirers, and copies of Bulletins of the Advisory Council were distributed to persons who were likely to make use of them. As the result of an inquiry from the Executive Committee, a valuable report on woods in this State which were, *prima facie*, of value for pulping purposes, and also the results of experiments carried out, were obtained from the Lecturer on Forestry at the University. Perhaps the most important work undertaken by the Committee was the compilation of a Catalogue of Scientific and Technical periodicals. This entailed a large amount of preliminary work, and arrangements were finalized under which the various scientific societies and Government Departments undertook to assist.

5. Western Australia.—During the year ten meetings have been held, and interest in the work of the Council has been well maintained. Changes in *personnel* have been caused by the resignation of Mr. Malcolm Fraser, Government Statistician, and the appointment of his successor in office, Mr. S. Bennett, F.I.A., and by the appointment of Mr. C. S. Nathan as an additional member of the Executive at the request of the State Government. Mr. I. H. Boas, Technical School, Perth, has continued to act as Secretary to the Committee.

Three Special Committees, appointed by the Committee on the recommendation of the State Committee, have continued at work, viz., the Committees on Redgum Tannage, on Tuberculosis in Stock, and on Pottery Clays. Reports of these appear in another place. In addition, the State Committee has taken an active part in the formation of Special Committees of an Inter-State character, dealing respectively with the utilization of native phosphates and with seed improvement, and is represented on both of these. An active interest has been taken in the

work of these Committees, which, although directly responsible to the Executive, have also reported to the State Committee. It has always been felt where Special Committees were appointed, and all association with the local Committee consequently ceased, that this would tend to weaken interest in the work of the State Committees. At the request of the State Committee, the Executive has now asked such Committees to report also to the State body.

During the year the Committee has been impressed with the point that much remains to be done in defining the functions of the Council, and more especially in arranging co-operation with the State authorities before grants are made for research work, for the conduct of which the Council itself possesses no facilities. The Hon. the Minister for Industries in this State has recently established a State Council of Industrial Development, and friendly relations have been established with this Committee, which it is hoped will prove beneficial to progress. The Minister himself continues to take an active interest in the work.

A question which has appeared of vital moment to the Committee is the establishment of a Forest Products Laboratory in Western Australia. The Committee has frequently brought the matter under the notice of the Executive, and is gratified to know that there is some probability that such a laboratory will be established.

A sub-committee on Plant Acclimatisation, under the chairmanship of the Hon. Walter Kingsmill, has held six meetings, and has distributed over 200 packets of seeds to various applicants. At the instigation of the State Government, a sub-committee was appointed to investigate the recovery of potash from sea-weed, and has held several meetings. Investigations show that local sea-weeds are rich in potash. A third sub-committee dealing with Timber Waste has continued its work, particularly in inquiries as to the products of distillation. It is now seeking a grant to continue experiments locally. The Chairman and Mr. Sutton attended an agricultural conference in Melbourne in November.

A considerable amount of local correspondence has been received during the year. Most of this has been dealt with by the Committee, but in special cases reference has been made to the Executive. Several suggestions have been received for new processes of manufacture, but none of them seemed feasible.

6. Tasmania.—The work of the Tasmanian State Committee during the year under review has been of an interesting nature, but, owing to the limited amount of industrial and scientific work going on in the State, of a necessarily limited character. At the beginning of the year careful consideration was given to the work to be undertaken by the Committee, and a decision was come to that it was desirable to concentrate the available energy upon one or two subjects rather than to generally touch upon a large number. As a result it was decided to concentrate upon the question of the utilization of forest products and the general development of forestry in the State. Considerable preliminary work was done in this connexion, a scheme of investigation drawn up, and finally a deputation consisting of members of the State Committee and several influential members of the Chamber of Commerce waited upon the Premier of the State in order to urge upon the Government the necessity of adopting a forward forest policy. The deputation received a sympathetic hearing, and, as a result, the Premier convened a Conference to discuss the question, and a Committee has been appointed by the Government to advise them on the subject.

The great demand for potash in this State and elsewhere gave the lead to an investigation into the commercial possibilities of the large deposits of kelp around the coasts of Tasmania. A Special Committee was appointed, and considerable work has been done, which has been reported upon to the Central Executive.

The following subjects have been discussed fully, and reports submitted thereon :—(a) The proposal of the British Trade Commissioner regarding the training of Australian Engineering Students in English factories; (b) the question of improving Primary Industrial Education.

Experiments are now being made at the State Farm with a view to testing the suitability of Posidonia Fibre for the packing of fruit. Repeated efforts have been made during the year to gather information for the Industrial Problem Census. It is particularly unfortunate that manufacturers have so far shown a disinclination to admit the necessity of any scientific investigation into their work, and up to the end of the year replies received from manufacturers state that they have no problems needing investigation.

Special Committees have been appointed and have done good work, in regard to which they have reported direct to the Central Executive :—

- (a) Special Committee on Tuberculosis in Stock.
- (b) Seed Improvement Committee.

Further work has already been done on the following matters :—(a) The development of the Catalogue of Scientific and Technical Literature; (b) consideration of the application of electricity to existing industries; (c) consideration of the question of a possible substitution of local resources for present imports.

Mr. W. F. Vincent, B.E., Hydro-Electric Department, Hobart, has continued to act as Secretary to the State Committee.

PART VII.—FINANCE AND CONCLUSION.

1. General.—A grant of £10,000 was made by the Federal Government to cover the cost of the investigational work of the Advisory Council during the financial year 1917-18. In addition, expenses for administration were allowed as approved by the Minister. It was provided that the total expenditure in respect of fees payable to members of the Executive Committee should not exceed £2,000 per annum. The actual expenditure on such fees during the year 1917-18 amounted to only £674. The grant of £10,000 included a sum of £4,000 to be expended on the scheme for the control and eradication of the prickly-pear. As that scheme, which provided for a contribution of £2,000 each from the Governments of New South Wales and Queensland, has not yet been accepted by the former State, it was impracticable to begin the work during the financial year.

2. Expenditure.—The total expenditure incurred by the Advisory Council during the financial year 1917-18 is £7,174, comprising £196 for expenses of the Advisory Council, £2,792 for fees and expenses of the Executive Committee, salaries of staff and incidental expenditure, £311 for State Committees, and £3,875 for investigational work. The following statement gives particulars of the expenditure. The figures given are subject to slight revision, since it has not been practicable to obtain in all cases, at the date of publication of this Report, complete returns of expenditure of State and Special Committees during the period from the 1st July, 1917, to the 30th June, 1918.

COMMONWEALTH ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

STATEMENT OF EXPENDITURE DURING FINANCIAL YEAR 1917-18.

	£		£
1. Advisory Council—		4. Special and Standing Committees and Conferences—	
Travelling and out-of-pocket expenses of members attending meetings	196	Agricultural Conference	250
Total	196	Alcohol Fuel and Engines	134
		Alunite	286
2. Executive Committee—		Blow-fly Investigations, Queensland	112
Attendance fees of members	674	Catalogue of Scientific Periodicals	95
Travelling and out-of-pocket expenses	44	Damage by Insects to Stored Grain	52
Salaries and travelling expenses of staff	1,638	Electrical Sterilization of Milk	4
Petty cash	48	Ferro-alloys	47
Postage and telegrams	90	Flax Industry Committee	38
Office furniture, stationery, printing, caretaker's attendance, hire of typewriting machines, &c.	298	Grass-tree Resin	4
Total	2,792	Kelp Investigations	38
		Marine Biological Economics of Tropical Australia	148
3. State Committees—		Mechanical Cotton Picker	112
New South Wales	50	Mode of Occurrence of Gold	562
Victoria	14	Posidonia Fibre	61
Queensland	156	Tick Pest (Life-history)	870
South Australia	29	Tanning Methods in New South Wales	227
Western Australia	43	Tanning, Mangrove Bark, Queensland	15
Tasmania	19	Tanning, Western Australian Red-gum	17
Total	311	Tin-plate Substitutes	7
		Worm Nest Investigations	647
		Yeasts and Breadmaking	149
		Total	3,875
		TOTAL	£7,174

3. Confidential Investigations for Defence and Navy Departments.—A number of highly important investigations has been undertaken by the Executive Committee at the request either of the Defence Department or the Department of the Navy. They relate mainly to the utilization of raw materials in Australia for defence purposes and to the manufacture in the Commonwealth of materials and supplies which are essential for these purposes. These investigations are of a confidential nature, and particulars cannot therefore be disclosed.

4. Shortage in Supply of Trained Investigators. One effect of the war has been to emphasize the fact that national well-being can be secured only when the relation between it and scientific progress is understood. The result is that nearly all civilized countries are speedily establishing national institutions for the application of science to industry, and in most cases are expending large sums of money in the erection of national laboratories for scientific and technological research. One of the greatest difficulties encountered in this movement is the shortage in the supply of properly trained scientific investigators, and in no country is this shortage more marked than in Australia. The Executive Committee has already met with considerable difficulties in this respect, and in more than one case has been unable to institute researches into important problems owing to the fact that it has been found impracticable to secure the services of properly qualified investigators to carry out the work.

If the work of the proposed permanent Institute is to be developed efficiently it is essential that steps be taken forthwith to increase the supply of research workers. While it is true that the dearth of such workers is exaggerated at the present time by the fact that a large number of Australian chemists and other trained investigators is engaged either in Great Britain or Australia on munition and other work connected with the war, the shortage is by no means merely of a temporary nature. It is therefore of the highest importance to our national welfare that increased facilities should be afforded for the training of research experts, and that better inducements should be offered both to men and women to undergo such training. In the opinion of the Executive Committee, this object could best be achieved, firstly by the provision of a number of research scholarships at Australian Universities, and, secondly, by a recognition of the just claims of scientific experts to more adequate rates of remuneration. This applies not only to the authorities who control the rates of salaries of scientific experts in the Commonwealth and State Public Services, but also to many of those who are in control of industrial establishments. If the present short-sighted policy in this matter continues to prevail, the successful development of many of our industries cannot fail to be impeded and jeopardized, and unless steps are taken to remedy the existing state of affairs, the position of Australia, in the industrial competition which will follow the termination of the war, must be looked forward to with misgiving.

5. Acknowledgments.—The Committee desire to express their appreciation of the kindness of the Inter-State Commissioners in providing accommodation at their offices for the Staff and for the meetings of the Advisory Council and of the Executive.

Further, they wish to acknowledge the valuable assistance they have received from a large number of persons throughout the Commonwealth, including correspondents who have forwarded valuable suggestions and information, and authorities on various subjects who have been good enough to attend meetings of the Executive to place their knowledge of these subjects at the disposal of the Committee.

Their thanks, and those of the Commonwealth as a whole, are also due to the numerous individuals who are voluntarily giving their time and skill in the hope of solving the various problems dealt with in this Report. Without their gratuitous assistance it would have been impracticable for the Executive to have carried out the greater part of the investigations that have been initiated.

In conclusion, they desire to place on record the efficient services of the Office Staff, which has spared no pains to further the work on which the Committee have been engaged during the year.

(Signed) ORME MASSON,
Deputy Chairman.

(Signed) GERALD LIGHTFOOT,
Secretary.

314 Albert-street, East Melbourne,
31st July, 1918.

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